How to Use CEMENT *for* CONCRETE Construction

HOW TO USE CEMENT *for* CONCRETE CONSTRUCTION *for* TOWN *and* FARM

Including Formulas, Drawing and Specific Instruction to Enable the Reader to Construct Farm and Town Equipment.

AN IDEAL BOOK FOR AGRICULTURAL SCHOOLS.

BY

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INTRODUCTION.

For a number of years there has been a growing tendency in city, town and country to build with greater thought of the future. Many persons have realized that some of the building methods far too common in the past have, in a short time, proved most costly in spite of the seeming low first cost. Depreciation has been rapid, continual maintenance in the form of paint, repair and general upkeep costly, and within a relatively short time depreciation has progressed to such a point that the cheapest recourse has seemed rebuilding. When this rebuilding has been done with permanence and fire-safeness in view by using concrete, those who have witnessed the fruits of their labors have soon realized that any slight increased first cost of concrete has soon been offset because first cost has proved to be last cost.

The author desires to mention here that in addition to claiming some special knowledge on the many and varied uses of concrete, he also was raised on a farm and operates one at the present time. For that reason, pursuit of the engineering profession has never made him lose sight of a farmer's viewpoint and needs, and in his own farming practice he has had many opportunities to prove the economy of concrete first and last.

Also, long association with the Portland Cement Association in the preparation of its many informative booklets on concrete has favored him with access to material which otherwise would not have been available to make this book as comprehensive and practical as it is felt has been done through this fortunate connection.

THE AUTHOR.

Chicago, October, 1919.

FARMING WITH CONCRETE.

Most of those unpleasant chores which in the past have made the farm boy and girl look cityward have had their origin in such uninteresting and unending performances as forever repairing, painting straightening up and cleaning around and in farm buildings—never getting anything really done because always working under the handicap of buildings and fences that would not stay built, that were always needing some kind of repair.

That lack of durability which has characterized farm and town buildings in the past is easy to explain, and perhaps one day it had a satisfactory excuse. A glance at typical farm and small town structures in many parts of the country makes it clear that little planning for the future was done when plans for the present were made. Some years ago wood was more plentiful and much cheaper than now, was usually near at hand, and because the building problem was not analyzed then as now, seemed well adapted to all immediate needs.

The small town carpenter was sufficiently skilled to build a fairly good farmhouse, barn or other structure and usually planned as he went along. Frequently the farmer himself was an amateur carpenter of no little ability and due to a mistaken notion that first was more important than last cost, it was natural that construction which soon proved of temporary character was chosen in place of that more closely approaching permanence. Such wide propensity to build upon the sand rather than the rock must be paid for. It is paid for

in large measure by the enormous annual fire losses which this country suffers, averaging as they have in the neighborhood of $250,000,000 yearly for a number of years. Fire insurance does not protect against loss except in a small degree. It returns part of the loss in money but can never replace the loss of labor and materials. In this respect every fire is a distinct drain on our natural resources, while every building planned and built with a view to longest possible life may be classed as an asset, something which increases our national wealth.

But fire loss is not the only loss. Depreciation on the classes of construction that have been most common in the past is so rapid that to maintain buildings in the nearest possible condition to new throughout a period of say twenty years, requires an amount of money nearly equal to and perhaps greater than first cost. So in the end cheap structures are the most expensive. Painting, repairing rotted parts, pointing up poorly laid masonry, putting on new roofs from time to time take money and represent lost labor and waste capital.

Concrete has been a great medium in making for greater efficiency in town and country. There is not a farm task that must be carried on where buildings and other farm improvements are of concrete that is not, as a result of its use, more of a pleasure and less of an expense. Let us remember that concrete is the nearest approach to permanence yet discovered in a building material. The man who foots the first bill foots the last one at the same time. No painting is required, there is nothing about it to rot; it is in the highest degree sanitary. It prevents the enormous losses due to rats and mice. It is wind, fire and earthquake proof.

No farm building can be named that cannot be built of concrete, wholly or in part, and cannot be better built

of concrete than of any other material. To prove this it is only necessary to make an imaginary tour around an imaginary farm and see where concrete may be used.

In the barnyard is the old wood watering trough which is forever going to pieces because left empty for sun and wind to work havoc upon. Finally it rots out and needs replacement. Nothing like this happens when the trough is built of concrete. It will not only be permanent, it will be clean and easy to keep clean. Leaving it empty will not cause it to go to pieces. Wet or dry it cannot rot. There are no hoops about it to tighten, nothing to rust out, no need of painting or other repairs. The same holds true of feeding troughs.

Think of the old splintering filth soaked floors in the barn, stable and other out buildings. How much of the daily labor that is now expended in useless endeavor to clean up and keep them clean would be done away with forever by replacing such construction with permanent concrete floors, upon which a few bucketfuls of water could be thrown or a hose turned on, followed by a good scrubbing with a broom and then by cleanliness?

How much more would the stock enjoy their food and drink from clean concrete mangers? How much safer would the general health of the stock be with the sanitation of concrete everywhere about them, and how many millions of dollars a year does this country lose through epidemic stock disease due almost wholly to insanitary stock quarters and surroundings? How much of the manure that the stock makes is now lost simply because there is no watertight manure pit in which to hold it until convenient time comes for hauling it out into the fields? Millions of dollars of soil fertility are lost this way through improper handling of

stable wastes and the consequent loss of the valuable fertilizing elements which they contain.

The progressive farmer today would not think of farming without a silo. But has he a concrete silo, permanent and fireproof, a sure safeguard against loss of valuable food supply by fire instead of one in imminent risk of suddenly going up in smoke with the resultant loss of a whole season's crop? Is there a permanent concrete barnyard wall enclosing the barnyard, built to stand, and serving as a windshield to make the barnyard fairly comfortable for outdoor exercising of stock on cold days?

How about the barn? Are the old boards coming loose every little while, sometimes falling off? Are there cracks between them through which drafts contribute to cold and pneumonia in stock? Do the stock have to wade through and stand in mud to get the feed which you throw out to them in the barnyard, and how much of such feed do they really get? Is it not true that they would enjoy their food on a clean smooth concrete floor just as you do on a clean inviting table cloth? Would not all the loss which now takes place be saved by feeding on a concrete barnyard pavement and at the same time would not sanitation of the barnyard be so improved that disease if it got a foothold could not maintain it? Every bit of barnyard droppings could be swept into the manure pit. Not a particle of the fertilizing value of the stock waste would be lost. Every rain would help to keep the concrete pavement clean and sunlight would do its share to prevent or kill disease germs. This is only a hasty glimpse around the barn surroundings.

There is no farm where milk is not produced at least on a limited scale if not as a specialty. Milk, if one expects to sell it nowadays, must be produced under

cleanly surroundings. Babies live or die on milk. There is no other food upon which the public is more dependent. There is none so dangerous to the public as milk that has not been properly handled from the time it is drawn until it reaches the consumer, or improperly handled at any stage of that journey. An old filthy ramshackle shed over the spring is not a good place to keep milk, neither is the habit of keeping it in a bucket hanging on a rope dropped down the well good practice. There should be a concrete milk house on every farm large enough to meet the requirements. Arrangements should be made to supply to this house a plentiful supply of clear cool water or to have available a home stored stock of ice that can be used to keep milk cool in cans in a concrete milk cooling tank until taken to town or to the nearby creamery.

Frequently it is convenient and easy to combine the milk house with an ice house and if so concrete construction is best for both. Wood sills and lower portions at least of frame construction soon rot away. Besides, strange as it may seem, spontaneous combustion is not uncommon in ice houses and fire may destroy all of the winter's harvest.

Inside the milk house a concrete tank for milk cooling, a smooth, dense, watertight concrete floor, concrete foundation for the milk separator and a smooth, dense wall surface of concrete make for a measure of sanitation that can hardly be duplicated in any other way. Neither hot nor cold water injures concrete and when milk house cleaning day arrives, hot water and scrubbing is all that is necessary to make the house clean and sweet and keep it so.

On many farms a special barn is devoted to dairy stock. These animals need well lighted, well ventilated, clean sanitary fly-proof quarters, if they are to give lots

of pure, high grade milk. Concrete in dairy barn construction makes for cleanliness, sanitation, fire safeness, and profitable milk production. With concrete floors, concrete mangers, concrete manure gutters connecting with the concrete manure pit, thus saving both liquid and solid manure, the ideal barn is evolved.

In this hurried trip over our imaginary farm, we could probably think of more uses for concrete about the dairy house. These few, however, are enough to suggest its possibilities and a reason for singling it out for preference as a building material.

An examination of the poultry house and the requirements for profitable poultry raising points to concrete. Clean water and clean food are just as good for poultry as for other farm animals. Concrete water founts and feed trays would be a good thing. Rats are a great enemy to poultry, especially to the young chicks, and they are very fond of freshly laid eggs. Concrete foundations and concrete floors will build out rats and thereby increase poultry and egg profits. Feed stored in the poultry house may best be kept in a concrete feed bin. The whole poultry house in fact, excepting possibly the roof, may most conveniently and best be built of concrete in some one of the various ways in which this building material may be used.

In no other branch of stock raising is cleanliness more important than in hog raising. On the average farm we find filthy leaky wood floors and filthy watering and feeding troughs. Not being able to provide his own quarters and feeding facilities, a hog, in spite of the unfortunate reputation clinging to him, would prefer to eat and sleep amid cleanly surroundings rather than the reverse. Remember that it is the owner who has made the hog what he is. Of course today almost anyone would build the hog house foundation of concrete and

possibly would use concrete for the floors. No trouble follows the use of concrete floors in stock quarters if the animals are kept well bedded. Concrete floors can be no colder than the interior of the building in which they are located. If the building itself is too cold for the animals, naturally the floor will be too cold. There should be a feed bin of concrete in the hog house too. Rats can't get into that. But there is no use stopping with floor, foundation, feed and watering troughs. The walls also should be of concrete for just the same reasons as have been given for using concrete throughout other structures.

Just as in the barnyard we need to introduce the economy and sanitation resulting from the concrete pavement, we need a concrete feeding floor in the hog lot. No more throwing corn into the mud to be trampled under foot and have half of it lost.

All the trouble of scrubbing and dipping hogs in the old fashioned ways can be done away with by letting them attend to it themselves and they will do it very willingly if provided with a clean concrete hog wallow. The hog makes his own wallow of mud in the absence of being provided with one that is clean and can be kept clean. Emptied and scrubbed out occasionally and filled with clean water upon which a little germicidal solution can be poured, the hog will keep himself free from insect pests and skin diseases which are almost wholly the result of filthy insanitary quarters.

Some farmers think more of their out buildings and stock than they do of the house, the housewife and the family. Leaving the farm buildings for a minute and going into the farm house we can soon see how the examination we have made of the other buildings points to the advantageous uses of concrete around the house. Of course, like any other structure, a house should rest

on a good foundation. It can't be much of a house on a poor foundation, so we might as well start with concrete. The concrete foundation well made will give us a clean dry cellar which is what we want, and we won't forget to lay a concrete floor to finish up the job as it should be. We will have to get in and out of the cellar at times and will need steps. Wood steps do not last very long when they are in contact with the soil, so we might just as well build the steps and their side walls of concrete. The house porches, both front and rear, give a good deal of trouble if built of wood. Use concrete there. The great variety of ways in which concrete can be so used, namely in the form of block, railings, columns, singly and combined, makes it possible to build a concrete porch in keeping with the house no matter of what material it may be made.

Many trips have to be made from the house to the wood shed, to the smoke house and to other out buildings. Sometimes this route looks more like a trail of mud than anything else. That would never happen again if there were concrete walks leading from the house to all those places to and from which trips must be frequently made in all kinds of weather—especially where the women folks have to travel more or less. We might as well think a little more of the women anyway, their lot is none too easy, shut up as they are on the farm, kept away from town by bad roads and forever cleaning up the tracking of mud on their floors, rugs and carpets due to the filth brought in by the farmer and his help.

Let's not leave the house without remembering that many farm houses today are being built of concrete because the ones first built of this material have proved so thoroughly the adaptability of concrete that the day is fast approaching when it will be the almost

universal house building material. The very nature of concrete properly used makes it provide a house which has a dry interior and one least affected by wide range of temperature changes outdoors.

The well curb and platform ought to be of concrete because pure drinking water is very important. Well water can readily be contaminated from slops and other waste carelessly thrown on the ground from the back porch.

Today the farmer is in a position to enjoy and to want practically all of those appointments in the house that make the city home so convenient. The farm home without indoor toilet and bath is no place to live, but these conveniences on the farm demand that proper provision be made for disposing of household wastes. The farm home is not fortunately located as is the city one where the modern plumbing system can be readily connected to the city sewerage system. However, concrete has in a great measure helped to solve the sewage disposal problem on the farm. A concrete septic tank is a miniature waste disposal plant which properly installed is almost automatic in its operation and safeguards farm folks from the continual risk attendant on the use of the old time cesspool.

Most farm women will go to considerable trouble to collect rain water for wash day. They want soft water. All of the labor of collecting it can be done away with by building convenient to the back porch a concrete cistern into which water from roofs of farm buildings can be led and stored for the usual Monday needs.

All around the home grounds concrete will add a little touch of cheer and utility, if concrete posts are used for the grape arbor, concrete flower boxes set on concrete pedestals in convenient nooks around the house

and concrete lawn seats invitingly placed in shady spots. The time of day can be learned from the concrete sundial.

There are other buildings to be built of concrete. A root and vegetable storage cellar and machine shed where implements can be kept from that rapid and costly depreciation resulting from leaving the plow or other implement at the end of the last furrow or where the last job was finished at the end of the season. A smoke house, rat-proof concrete grain bins and concrete corn crib. An elevated water storage tank placed on top of the silo to furnish an immediate supply of water under pressure in case fire should break out in any of the buildings.

Nearly every farm today has an automobile. The concrete garage would not only safeguard the automobile from injury due to a fire in nearby buildings, but would prevent the menace of having the automobile and the inflammable oils necessary to its operation from becoming a menace to other buildings. The garage, therefore, should be of concrete.

Out in the fields the farm furnishes other suggestions where concrete may be used most profitably and to best advantage. A culvert across some waterway that must be kept open and that separates adjacent fields which must be reached frequently by team and wagon.

A drainage system in which concrete tile are used to reclaim lands now too wet for profitable cultivation or else kept entirely out of cultivation because a swamp the greater part of the year.

Concrete fence posts do away with that never ending replacing and repairing of fences that will not stay built.

A concrete dam to make a fish pond or an ice pond. Concrete troughs in the pasture lot. Concrete casing for the spring.

Concrete lined irrigation ditches to prevent that waste of water which is so costly in that portion of the country where water has a money value little realized by those who have plenty.

Evidently there are other opportunities for using concrete on the farm, and if by chance in our hurried tour among the buildings and over the land we have forgotten to name some structure, we have proved that those to which we have applied concrete are no different from the ones that we may have overlooked and that we can use concrete for them also.

When fire starts among the farm buildings it generally eats them up. Nothing but ruins remain in place of the well equipped plant which may a little while before have been paying good dividends. Fire, tornado and lightning are continual hazards on the farm. With fireproof construction naturally there is permanence, and concrete means both. It means also better sanitation and numberless other things which no kind of impermanent and fire trap construction can offer.

Our American farmers have only recently learned through a costly war what part of our national waste they are responsible for; have only just had the lesson of thrift and investment brought home. They are all interested in permanent buildings, better agriculture, all around general efficiency on the farm, and particularly in the profit which results from introducing and maintaining these efficiency measures. On the farm today all around general efficiency has its highest representation in permanent fireproof sanitary concrete buildings.

PORTLAND CEMENT.

Portland cement was first made in 1824 by Joseph Aspdin, a bricklayer of Leeds, England, whose process consisted in calcining a mixture of limestone and clay and reducing the resulting clinker to a powder. To this substance he gave the name of portland cement, because when it hardened a yellowish gray mass was produced resembling in appearance the stone found in the various quarries on the Isle of Portland south of the coast of England. This explains the origin of the name portland cement.

All portland cements are manufactured cements and for that reason it is possible to regulate or control their quality with extreme exactness, thus enabling the production of a uniform material. Of all the cementing materials, portland cement ranks highest in hydraulic activity. In fact, portland cement hardens most uniformly under water, and regardless of the manner in which used, whether in a mortar or to make concrete, sufficient water must be used in the mixture to insure full effectiveness of its cementing qualities.

First Portland Cement in the United States. It was not until 1875 that true portland cement was made in the United States. This was produced by a company near Allentown, Pa., in what is now known as the Lehigh District, where a greater quantity of portland cement is made today than in any other section of the United States. About the same time that the company produced portland cement, a plant was built at South Bend,

Ind. Shortly afterward plants were built at Wampum, Pa., Kalamazoo, Mich., and Rockford, Me. From a production of about 83,000 barrels in 1880 and less than 1,000,000 in 1895, the total annual production of portland cement in this country has risen to over 90,000,000 barrels.

Portland Cement Defined. The Standard Specifications for Portland Cement adopted by the American Society for Testing Materials define portland cement as "the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials and to which no addition greater than 3 per cent has been made subsequent to calcination."

This definition contains some formidable words and may need explanation. Reduced to simple language, portland cement is: First, composed of limy and clayey substances. Second, these materials must be properly proportioned, which includes selecting and screening the raw material. Third, the correctly proportioned materials must be thoroughly mixed, which means that they must be dried and finely ground so that this mixing will be possible. Fourth, the correctly proportioned and mixed materials must be burned to a clinker under a degree of heat that will cause them to fuse or melt. Fifth, this slag-like product, or clinker, must be ground to a powder.

Composition of Standard Portland Cement. The last clause in the definition provides for the addition of a small amount of some material to regulate the setting time, but limits the quantity of such a material to prevent adulteration of the cement.

The composition of a standard portland cement is usually within the following limits:

COMPOUNDS	PER CENT LIMITS
Silica	20 to 24
Alumina	5 to 10
Iron Oxide	2 to 5
Lime	60 to 65
Magnesia	1 to 4
Sulphus-oxide	.5 to 1.75

Distribution of Raw Materials. Nature has provided an abundance of the limy and clayey materials suitable for the manufacture of portland cement. The limy or calcareous variety is always in the form of calcium carbonate, such as limestone, chalk, marl or the precipitated form obtained as a waste product from the manufacture of alkalies. The argillaceous or clayey division includes clay, shale and slate, cement rock and selected blast furnace slag. Cement is made in this country from all these materials, each plant using one of the calcareous combined with one of the argillaceous materials.

Classification of Processes of Manufacture. Portland cement may also be considered as belonging in one of three classes, according to the method of manufacture, which are as follows:

1. Wet Process
2. Semiwet Process
3. Dry Process

In the wet process, confined principally to plants using marl, the raw materials are ground and fed into rotary kilns in the form of a "slurry" containing sufficient water to make it of a fluid consistency. In the semi-wet process a similar but drier slurry is used. while in the dry process, raw materials are ground, mixed and burned in the dry state. Most of the cement manufactured in the United States today is made by plants operating the dry process.

NATURAL CEMENT

The cement industry in the United States began with the discovery in 1818 of a natural cement rock in Madison County, N. Y. Seven years later, cement rock was found in Ulster County, N. Y., along the Delaware and Hudson Canal, and in 1828 a mill was built in Rosendale, N. Y. It was from this place that the natural cement obtained its name, that is, natural cement in this country has usually been referred to as Rosendale cement. James Parker's patent already referred to involved the manufacture of natural cement. Natural cement has good hydraulic qualities, but it has been almost entirely superseded by portland cement because of the superior strength, hardness and more constant composition and quality of the latter.

Natural cements are made from cement rock, which is clayey magnesium limestone, containing clayey matter varying from 13 to 35 per cent and usually containing a comparatively high percentage of magnesium carbonate. Louisville cement is similar to Rosendale cement but contains less magnesia. It is made from cement rock found in the vicinity of Louisville, Ky.

Natural and portland cements should never be mixed. To use natural cements successfully requires a greater degree of skill and attention than is necessary with portland cement. If too much or too little water be used in the mortar or concrete mixtures in which natural cement is the binding material, it will harden unequally, crack and adhere badly to the aggregates. Natural cements are but little used today.

USEFUL DATA

Weights and Measures. Portland cement weighs 376 pounds per barrel net.

Portland cement weighs per bag 94 pounds net.

In proportioning mixtures 1 bag or sack, 94 pounds net, is considered as 1 cubic foot.

Natural cement weighs per barrel net, 282 pounds; per bag, 94 pounds.

Loose portland cement averages per cubic foot about 92 pounds.

Weight of paste of neat portland cement averages per cubic foot about 137 pounds.

Volume of paste made from 100 pounds of neat portland cement averages about .86 cubic foot.

Weight of portland cement mortar in proportions 1:2½ averages per cubic foot 135 pounds.

WEIGHT OF PORTLAND CEMENT CONCRETE PER CUBIC FOOT

Cinder concrete averages 112 pounds.

Conglomerate concrete averages 150 pounds.

Pebble concrete averages 150 pounds.

Limestone concrete averages 148 pounds.

Sandstone concrete averages 143 pounds.

Traprock concrete averages 155 pounds.

A carload of portland cement varies from 400 to 600 sacks or bags.

All mills now pack portland cement in standard packages (cloth sacks and paper bags) weighing 94 pounds net and considered as 1 cubic foot when proportioning mixtures by volume, which is the common method. Four of such sacks or bags make a barrel. Cloth sacks are billed to the cement purchaser, and when empty they may be returned to the dealer from whom the cement

was purchased, or to the mill, and the manufacturer will buy them back if they are in good condition and suitable for further use as cement containers. A cement sack which has been wet, torn, or otherwise rendered unfit for use, will not be redeemed.

Although cement is sometimes packed in paper bags, this practice is not so general as the use of cloth sacks. A charge is made for packing cement in paper bags. These, of course, are not redeemable.

In returning cloth sacks for redemption, railroad companies require that the sacks be bundled in a certain manner. Cement mills also have regulations governing the return of sacks. Any railroad freight agent can inform a shipper as to how sacks must be bundled and marked to come within the requirements of railroad rules governing such shipments.

WHAT CONCRETE IS, HOW TO MAKE AND USE IT

Some Fundamental Principles. When portland cement, sand, and pebbles or broken stone are properly combined, mixed with water and allowed to remain undisturbed, the resulting mass will finally become as hard as stone. This is concrete. In other words, concrete is artificial stone—a manufactured product—so its quality depends largely upon the materials of which it is composed and the care used in combining and placing the mixture.

While in the plastic state concrete is placed in forms prepared especially to receive it, and the fact that when it hardens it assumes the shape of any mold or receptacle in which placed, has made it one of the most useful and adaptable of building materials.

Almost every one has some knowledge of the possible uses of concrete, but a great many persons who know how it may be used to build permanent, expense-proof, fireproof concrete structures are not fully impressed with the fact that concrete must be made and used according to well defined rules or principles if success in its use is to follow.

Many people think that success with concrete work, that is, the satisfaction from using concrete as the building material for any structure, depends largely if not entirely upon the portland cement. This is true only in part. Of course the portland cement must be good, but so must the other materials. The sand and pebbles or broken stone must be clean, hard and durable. They must be well graded from fine to coarse so that voids or

air spaces in their bulk or volume are reduced to a minimum, for only in this way is it possible to obtain a dense mixture, and with good materials density means strength.

Mixing water must be clean, free from oil, acids and alkali. The materials must be proportioned by careful measuring—not by guess.

Little thought need be given to the portland cement. All of the well-known brands are manufactured to meet what are known as "Standard Specifications," that is, the portland cement sold today has been so carefully made that when placed on the market its quality is beyond the question of users. If this were not so, manufacturers of cement could not long stay in business. Quality must be high to meet the requirements of Standard Specifications, and these have been made to establish the quality that has been found necessary for portland cement concrete.

Storage of Cement. The only thing that can happen to portland cement between the time it is made and purchased by the intending user, is that a careless dealer may have stored it in a damp place. If this happens to be the case, the cement will have caked. Any lumps in a sack of cement that cannot be broken by gentle pressure between one's fingers or in the hand should be discarded. Lumps of that kind are indication that the cement has been exposed to dampness, and it should not be used.

Sometimes cement piled in sacks at the bottom of high piles will apparently cake in the sacks owing to the weight of the pile, but such caking lumps are readily broken under slight pressure of the hand and therefore are no indication that the cement has in any way been damaged in storage. It is therefore of prime importance that cement be carefully stored until it is used. It

should never be piled upon the ground because the ground always contains some moisture and the cement will absorb this and very soon start to harden.

Aggregates. In speaking of the various materials of which a concrete mixture is composed, the sand and pebbles or broken stone are referred to as aggregates. Sand is called "fine aggregate," while broken stone or pebbles are called "coarse aggregate." Sometimes fine stone screenings of specified size are used in place of sand, and when so used may be considered as sand.

In describing the requirements which sand and pebbles or broken stone must meet in order to be suitable for use in concrete work, it is usually stated that the sand (or stone screenings if these are used instead of sand) shall be free from all such foreign material as loam, clay and vegetable matter, or humus. It is also necessary that the sand be of a kind that has had its origin in a tough, durable rock.

Gravel screened for a concrete mixture, separating the fine and coarse materials. This illustrates clearly how much greatly in excess of coarse material the sand is in the average gravel bank.

Size of Aggregates. The maximum size of the material commonly referred to as sand is usually fixed at ¼-inch, and from that size downward it should be uniformly graded to the finest permissible particles, with, however, the coarser particles predominating. Such grading contributes to the strength and density of the concrete in which used, because sand so graded will have a small volume of voids or air spaces in its bulk and this will help to produce a dense concrete, which also means a strong and water-tight concrete.

Clean Materials Important. Pebbles or broken stone must also be free from the same classes of foreign material that would be objectionable in sand. In addition, the particles should be free from any coating of clay, dust or other matter, because the presence of such a coating will keep the cement from coming in contact with the surface of the particles and thus prevent it from performing the duty intended, namely, that of eventually binding the sand and pebbles together into a solid mass like stone. Pebbles or broken stone as used in the general run of concrete work may range in size from ¼ up to 1½ inches or more in maximum dimension, depending upon the class of concrete work for which the concrete is to be used.

TESTING SAND FOR ORGANIC IMPURITIES

A simple test has been developed for determining whether a particular sand contains sufficient organic impurities to make it unfit for use in concrete. This test is one that can be made by anybody, and in a short time. A 12-ounce graduated prescription bottle is filled up to the 4½-ounce mark with the sand to be examined; then a 3 per cent solution of caustic soda is added until the level of the liquid reaches the 7-ounce mark. The bottle is corked and shaken thoroughly and then set aside for 24 hours.

By observing the color of the liquid, the quality of the sand for concrete may be determined as far as the presence of organic impurities is concerned. If this liquid shows practically clear or not darker than a straw color, the sand may be considered as sufficiently free from organic impurities to be used in all classes of concrete work. If the liquid is more nearly a dark amber color, the sand should not be used for concrete excepting where the work is relatively unimportant. If the liquid is darker than this, the sand contains too large a percentage of organic impurities and is unfit for use in concrete.

It is possible that by washing sand which is unsuitable, it may be improved somewhat in quality but usually it is more economical to obtain sand from another pit than to attempt to improve the sand which the test shows unsuitable.

The graduated prescription bottle and the 3 per cent solution of caustic soda can be obtained from any druggist. Pebbles or broken stone also should be hard, tough and durable. In heavy foundation work the maximum size of pebbles or broken stone may range up to 2 inches or more, while in thin wall sections, especially where metal is used to reinforce the concrete, the coarse aggregate should not exceed ¾ of an inch or 1 inch in greatest dimension.

Washing Sand and Pebbles. Sometimes the only materials that a farmer can get for concrete work contain so much loam, clay or other foreign material that it is necessary to wash them before using in a concrete mixture. Sand and pebbles or broken stone can readily be washed by shoveling them into a trough set at an angle of about 35 or 40 degrees and turning water from a hose into the upper end and causing the materials to tumble down the length of the trough. If a suitable screen is placed at the lower end of the trough, the sand

can also be separated from the pebbles and the materials screened at the same time they are washed.

Plain and Reinforced Concrete. Concrete may be either plain or reinforced. The former consists merely of a mixture of portland cement, sand, pebbles or broken stone and water, placed in wood or metal forms that will give the mass the required shape or outline when hardened. Reinforced concrete is plain concrete into which steel in one of a number of different forms is embedded while placing the concrete.

Concrete, like many building stones, is very strong in bearing loads that are placed directly upon it, that is, it is strong in compression, but it is not so strong in resisting loads or strains that tend to bend it or pull it apart, that is, it is relatively weak in tension. That is why steel is embedded in concrete used for certain parts of a structure or certain classes of structures, since it gives to concrete the strength it lacks, as steel is very strong in withstanding pulling or bending strains. The use of steel in this way also results in considerable economy of concrete, because if the steel were not used it would be necessary to make the concrete much more massive, hence unnecessarily expensive.

Bank-Run Gravel. By far the commonest mistake that is made by most persons who lack a thorough understanding of what is required in concrete work, is that of thinking ordinary sand and pebbles as found mixed in the gravel bank on the farm or near by, are suited for concrete mixtures. No more serious mistake could be made. Almost without exception such sand and pebbles as found mixed in the pit are unreliable for concrete mixtures, because bank-run material contains far too great a quantity of sand in proportion to the amount of pebbles for the best strength and density of concrete. It will be found that bank-run gravel contains 40 per

cent or more of voids or air spaces. That is, if you were to take one cubic foot of such material and place it in a box that would exactly contain it, you would find that sufficient water could be poured into the box to equal nearly one-half of a cubic foot, indicating that the material had that volume of voids or air spaces in its bulk.

The only way to use the bank-run material is to pass it over a screen so as to separate the sand from the pebbles and then reproportion them in definite volumes. It may be necessary to pass the coarse material over a second screen so as to exclude all particles measuring over a certain maximum. For instance, if the work being done would not permit of using pebbles larger than 1 or 1½ inches in greatest dimension, then the material would have to be passed over a screen that would allow such particles to pass through and reject any larger ones.

The Best of Grading Still Leaves Some Voids. No matter how carefully materials such as sand and pebbles or broken stone may be selected, the bulk will contain some voids or air spaces. A certain volume of pebbles, say 3 cubic feet, will require nearly 1½ cubic feet of sand to fill the air spaces in its bulk; but the sand also has a similar quantity of voids or air spaces, and these likewise must be filled by using portland cement.

The Ideal Concrete Mixture. This brings us to the ideal concrete mixture, which is one in which the air spaces in the bulk of pebbles are reduced by the sand and the air spaces in the bulk of sand reduced by the portland cement. As ideal conditions cannot be obtained, it is necessary to be satisfied with the closest possible approach to the ideal. This is accomplished by so proportioning the various materials as to have the volume of sand about equal to one-half the volume of pebbles, and the volume of portland cement approximately one-half of the volume of sand. This system of proportioning will

produce a volume of sand-cement mortar slightly in excess of that required to fill the air spaces in the pebbles, and for general use will produce as near an ideal mixture as it is worth while attempting.

A simple example will show why the foregoing practice is necessary. A 1:2:4 mixture, for instance, means 1 sack (or 1 cubic foot) of portland cement, 2 cubic feet of well-graded sand and 4 cubic feet of well-graded pebbles or broken stone. When these materials are properly combined and mixed with water, the resulting bulk will slightly exceed 4 cubic feet. This proves that the sand has gone to fill up the voids or air spaces among the pebbles, and that the cement has gone to fill up the voids or air spaces in the bulk of sand. Now if instead of using the definitely proportioned 1:2:4 mixture, the concrete worker takes 1 sack of portland cement and mixes it with 6 cubic feet of bank-run material, he would then have 6 cubic feet of concrete containing 1 sack of cement as against slightly over 4 cubic feet containing the same quantity of cement. Remembering that in the 6 cubic feet of bank-run material, the voids or air spaces are nearly half the bulk, he can see that the 1 sack of cement has not nearly filled these air spaces, so 6 cubic feet with 1 sack of cement will not be as strong concrete as the other mixture, neither will it be dense nor watertight.

How to Make Concrete Watertight. Much concrete has been made in the past that has failed to give the good results and service that every one has a right to expect of this wonderful building material. But good results cannot be expected if these little principles of correct concrete practice are disregarded.

We often hear that concrete work is not watertight. Water cannot pass through a structure that has no voids or air spaces in it, each connected with another, so as to

form easy channels for the passage of water. Water-tight concrete may be secured for all practical purposes, first, by paying particular attention to selecting well graded materials, then correctly proportioning them, using the correct amount of water, mixing thoroughly, following careful methods of placing the concrete, and finally, giving it proper protection against too rapid drying out after placed. All of these subjects will now be touched upon briefly.

Proportioning and Mixing Concrete. After having selected proper materials and correctly proportioned them, comes the subject of mixing. Concrete can be mixed either by hand or by machine. Good concrete can be made either way. Of course, there is a litle more labor to hand mixing, but for many pieces of farm construction the expense of a machine mixer does not seem warranted. However, since concrete construction is going on all over the country, farmers would find it very advantageous to unite in bearing the cost of purchasing a small power-operated mixer that each could use by prearrangement when needed. It would take only a little time to make such an investment a paying one, and each one's contribution to the community mixer would soon be forgotten. Mixers of this kind that are very reliable can be purchased for from $75 upward. For example, a power-operated mixer for community use costing, say, $125 complete with gasoline engine all mounted on a wheeled truck, would keep anyone who used it once from ever attempting to mix concrete by hand. There is always a tendency to slight hand mixing, thinking that the last turning was enough when one more would have given it just the additional mixing needed.

If one has to mix concrete by hand, a few simple rules for doing it must be observed. Portland cement, although sold by the barrel, is generally shipped and ob-

tained by the user in sacks. These sacks weigh 94 lb. net, and in proportioning concrete mixtures are considered equal to one cubic foot. Cement therefore need not be measured, but arrangements must be made for measuring the sand and pebbles or broken stone. The most convenient device for doing this is a very simple one, merely a bottomless box which can be made so as to hold 1 cubic foot or 3, 4 or 5 cubic feet. If holding more than 1 cubic foot, then marks should be placed on the inside to indicate the depths corresponding to a volume of 1, 2, 3 or more cubic feet. A mixing platform is also required. This may be approximately 8 by 10 feet in dimensions, and should be made of lumber planed on one side and preferably tongued and grooved so as to furnish a smooth surface for shoveling, and tight joints. These strips should be nailed to 2 by 4's set up on edge, sufficient being used to make the platform stiff when working upon it. It is also well to put strips of 2 by 2 or similar material around three edges of the platform to prevent materials or the concrete from being shoveled off while mixing, also to prevent water carrying cement with it from running off the board when adding water to the combined materials.

Simple Tools Only Are Needed. The tools used for concrete mixing are few. Square pointed shovels, pails or hose with nozzle for adding water, wheelbarrows for perhaps wheeling the concrete to the place where it is to be dumped, are about all that are needed. In hand-mixing the measured quantity of sand is spread upon the mixing platform. On top of this is dumped the required amount of cement. The two materials are then turned a number of times until the absence of streaks of brown and grey indicate that they have been thoroughly combined. Now the mixed sand and cement are leveled off to a thin layer on the mixing platform. Pebbles or

broken stone, first thoroughly wet, are measured in the bottomless box. If a 1:2:3 mixture is being prepared there will have been mixed 1 sack of portland cement and 2 cubic feet of sand. On top of this there will be dumped the measured 3 cubic feet of wetted pebbles or broken stone. The broken stone and the mixed sand and cement should then be turned together several times until they have been fairly well combined, when water should be added slowly by pouring out of a pail or preferably by spraying on with a hose, some one turning the materials constantly while water is being added to prevent cement from being washed out of the mixture.

Amount of Water to Use. It is difficult to state the exact amount of water that should be used with any batch of concrete. It is far easier to describe a certain consistency which can readily be recognized after a little practice. Because sand may dry out when exposed to the wind and sun, certain batches may require more water than others, but if enough water is used so that the resulting mixture after being thoroughly turned four or five times is of a pasty or jelly-like consistency, this is the end which should be sought. Too little water will produce a mixture that cannot be consolidated to proper density in the form. Too much water will produce a mixture that will be sloppy and that in handling will cause the cement-sand mortar to separate from the pebbles. Such concrete cannot be placed so that it will have uniform density. The pebbles will drop out of the mixture and lie in pockets or bunches in the mass and will thus produce not only an unpleasing surface when forms are removed, but will also cause weak spots and spots that will permit water readily to pass through the work.

Use Clean Water. It is necessary that the water used in a concrete mixture be clean. Water that is

cloudy has clay or other foreign material floating about in it and is bound to in some degree affect the strength of the concrete. Water carrying a floating scum of oil or grease should not be used for concrete mixtures.

Machine mixing of concrete, as has already been mentioned, is preferable. A machine does not get tired, and if the batches are kept in the machine long enough, say not less than a minute or one minute and a half, it is almost certain that the concrete will be well mixed. Of course, in using a batch mixer it is necessary to observe certain requirements. The drum must not be revolved too rapidly because then the materials will tend to cling to the inner surface of the drum and will not be tumbled about sufficiently to be thoroughly mixed one with the other. Most concrete is not mixed long enough. All specifications for concrete work are now endeavoring to specify a stated time that the materials shall be kept in the drum. If all concrete mixtures were kept in the mixer for at least 1½ minutes there would be much better concrete as a result.

Methods of Proportioning Mixtures. Concrete mixtures, as has been intimated by several examples previously given, are usually proportioned by volume. A sack of portland cement is considered equal to 1 cubic foot. Mixtures are generally referred to as 1:2, 1:2:3, 1:2:4, etc. In the first instance this means that the figure 1 stands for sack or 1 cubic foot of portland cement, and the second figure for 2 cubic feet of sand or other fine material. That is, the 1:2 mixture is a mortar mixture. In the second example the first figure stands for one sack of portland cement, the second for 2 cubic feet of sand or other fine aggregate, and the third for 3 cubic feet of pebbles or broken stone. The same applies to the 1:2:4 mixture and for other varying proportions sometimes used.

While on very large jobs it pays to make accurate tests to determine the volume of voids in the sand and pebbles or broken stone so exact proportioning can be done, such refinements are not necessary on the average small jobs such as the usual run of home concreting. For this reason it has become common practice to proportion concrete mixtures by what is known as arbitrary methods. A table of such suggested arbitary mixtures follows. It will be noted in the various mixtures recommended that in practically every case the volume of pebbles or broken stone recommended is approximately double the volume of sand recommended, and that in the richer mixtures which are intended for work requiring strength and watertightness, the volume of cement used is about half the volume of sand.

Referring again to the quantity of water required in a concrete mixture, it should be mentiond here that water is a very important ingredient in concrete. Cement is the binder which firmly unites the sand and pebbles or broken stone into what eventually becomes a mass of artificial stone. It is the changes taking place due to the combination of cement and water that make the cement act as a binding material, and it cannot perform this binding action unless there is enough water to bring about the desired end. These changes resulting from the combination of cement and water are scientifically referred to as "hydration." This is in reality a process of crystallization. If there is not enough water in a concrete mixture, not all of the cement will be transformed as desired, hence its full effectiveness as a binding material will not be secured. On the other hand, if there is too much water used, the results will be almost as bad as though too little is used. Too much water produces an effect that is generally described as drowning

the cement. The importance of correct amount of water therefore is not to be disregarded.

Protection of Work When Finished. This suggests that after a concrete mixture has been prepared and placed in the mold or form that is to give it the required shape, every means should be taken to prevent the concrete from drying out too rapidly, because if the water that was added when mixing the concrete is lost by evaporation, the result will be practically the same as though too little water were used in the mixture.

Another thing should be borne in mind. Just as soon as water is added to the materials for a batch of concrete, the setting action in the cement, which is what causes it to harden, begins very quickly, and no time should be allowed to elapse between mixing and placing the concrete. It should be deposited in the forms just as soon as mixing is complete. In no case, however, should any concrete that has been mixed more than 20 or 30 minutes be used. The hardening action will have progressed far enough so that disturbing the mixture by remixing to soften it so that it can be handled, will weaken the binding effect of the cement and will thus produce a weaker concrete.

Different kinds of concrete work require protecting in different ways. Also concrete work done in summer must be protected in a different manner than that done in winter. As regards concrete work in winter or cold weather, more will be said later. Concrete deposited during the summer should be kept from drying out until it has properly hardened. Most people think that the hardening of concrete is due to a process of drying while in reality the opposite is true; that is, concrete hardens better and more uniformly in the presence of water than under other conditions; so after the concrete has been placed in the forms, some means must be taken to see

that none of this water is lost. It is all necessary to the changes that will take place in the cement, thus producing what really is concrete.

On heavy mass work, such as heavy foundations which are almost entirely below ground, not so much artificial protection of the work is necessary. Usually if the forms are left in place and the work is wetted down several times daily by sprinkling from a hose, all of the protection required will have been given. But on walls, pavements, walks and floors, all of which have a large area exposed to air and to the sun, it is necessary to apply some kind of a covering to the concrete just as soon as this can be done without marring the surface, usually two or three inches of moist sand or sawdust or a covering of hay or straw kept wet by frequent sprinklings for several days, accomplish the desired protection for floors and walks, while walls may be protected by the forms and wet down several times daily.

COMPRESSIVE STRENGTH OF CONCRETE

Strengths given may be expected from concrete made from standard portland cement and first-class sand and coarse aggregate, for concrete which has been well mixed and cured without drying out.

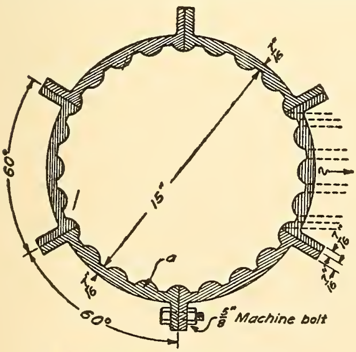
Mix by Volume	Average Compression Strength of 6 by 12-inch Cylinders (lb. per sq. in.), at the ages of			
	1 mo.	3 mo.	6 mo.	1 year
1:3 :6	1200	1700	2000	2400
1:2½:5	1600	2200	2600	3000
1:2 :4	2100	2700	3100	3500
1:2 :3	2200	2900	3300	3700
1.1½:3	2600	3300	3700	4100

MAKING FORMS FOR CONCRETE CONSTRUCTION.

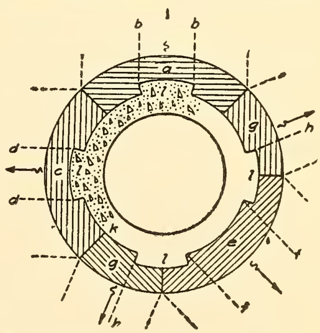
Immediately after mixing concrete is a plastic material, that is, it will assume the form of any receptacle in which it be placed. This characteristic of concrete is what makes it so comparatively easy to build or mold structures of it having almost any desired shape.

Forms or molds, therefore, may be defined as the receptacles in which concrete mixture is placed immediately after mixed so that when it has hardened the concrete will have the shape desired or intended.

Materials Used. Molds or forms for concrete are made from a variety of materials, depending somewhat upon the structure or object being built and shape which it is desired to give the object and the number of times it is desired to use the forms. Concrete forms can be made wholly of wood, or of wood metal lined, or entirely of metal, or in some cases plaster of Paris. Cast iron



Sectional Plan of Form for Fluted Column

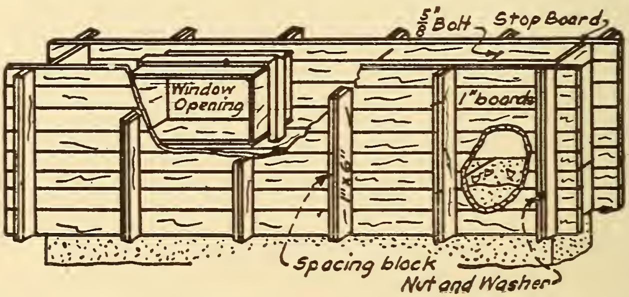


Product with projecting surfaces Correct and Incorrect methods

Sectional plan of form for fluted column and section of product with projecting surfaces showing correct and incorrect methods in each case of dividing form.

and steel forms or molds are used in machines that make concrete block, brick, tile, sewer pipe, ornamental cast stone trim, etc. Wood forms also are used for such objects but as the products just mentioned are usually cast or molded in large quantities, economy results from using a type of form or mold that is sufficiently durable to permit frequent and repeated use.

Metal Molds. Metal molds, or wood molds metal lined, are used when it is desired to give the concrete

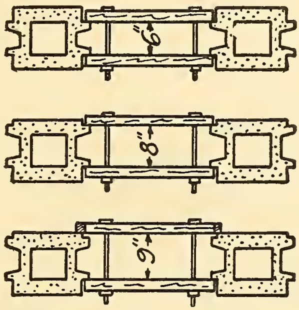


Sketch of forms in place for constructing concrete foundation wall above ground, showing how provisions are made to form window opening in wall.

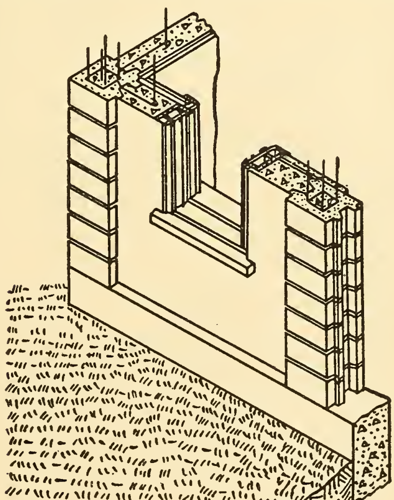
a particularly smooth surface and also where it is desired to repeat the construction of the same object or surface a number of times and therefore increase the life or length of service of the forms.

Forms Must Be Carefully Made. Form work is a very important step in the use of concrete for any building construction. No structure or object made of concrete can be truer in shape or form than the form or mold in which it is made and for small objects, such as flower vases, urns, flower boxes and other ornamental products, careful work done on the forms is well repaid in the satisfaction which the finished concrete work will give.

Practically every class of concrete work requires some form construction. The only exception to this is that when concrete for a foundation is being placed in a trench excavated in firm, self-sustaining earth, there need



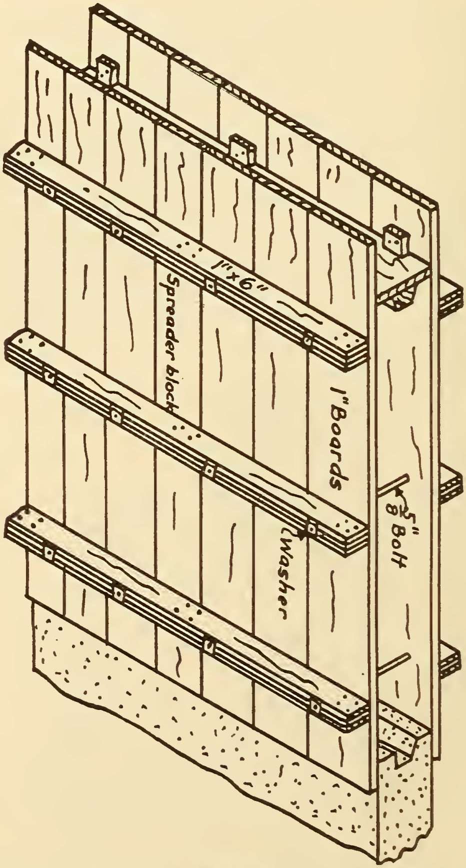
Method of making concrete block with lugs cast on the block to permit using simple form construction consisting of two or more planks as described in the text. Notice that by clamping the plank either against lugs or outside face of block, wall thickness can be varied within considerable limits. Blocks are first laid up in columns, then the core is filled with concrete.



Combination of block and monolithic wall construction produced by using the block and form system described in connection therewith, as shown in the preceding illustration.

be no forms for that part of the work underground—the walls of the trench will serve. For the work above ground, forms are needed.

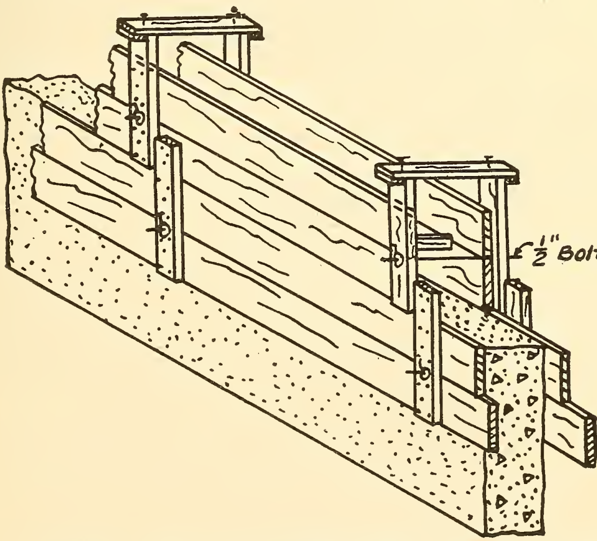
Wood Most Used. In the average run of concrete form work wood is used to a greater extent than any other material. For such structures as circular tanks and silos there are various types of metal molds on the



Sketch showing movable form panels for foundation or wall construction, illustrating also stop in the form to enable building complete one section and providing a proper vertical joint.

market devised with special reference to the class of work mentioned. There are also various types of so-called form systems, most of which, however, are patented and therefore cannot be used without paying the patentee some royalty, and these systems frequently involve metal or metal lined forms.

Because of the fact that no two concrete structures are rarely if ever alike, wood is more adaptable form material than any other even when certain sections of a structure must be practically duplicated a number of times on various parts of the surface. Wood forms can be so standardized, that is, built in such a combination of units, that they are very serviceable for such repeated use.

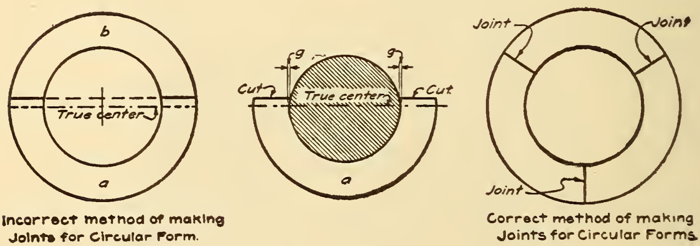


Sketch showing a type of movable concrete form for foundation or wall construction.

Quality of Lumber. When wood is used for concrete forms it is necessary that a good grade of lumber be used, especially where the appearance of the finished

surface is important. For work that is not to be exposed to view, high grade lumber is not so necessary. The wood should be free from warp, knots and other imperfections that would leave their imprint on the finished concrete surface, for while in a plastic state concrete very readily takes the imprint of any irregularities or rough surface with which it may be in contact.

For ordinary concrete work, such as foundation walls and other surfaces which are not to be permanently exposed to view, the lumber used need not have the smooth, regular finish otherwise desirable. The principal thing to observe in such a case is that the lumber is sufficiently strong, as it will in some cases be used where the forms will have to support a considerable weight of concrete until the concrete has hardened. Unplaned lumber will do where the concrete surface is



Correct and incorrect methods of cutting joints in form used on circular object.

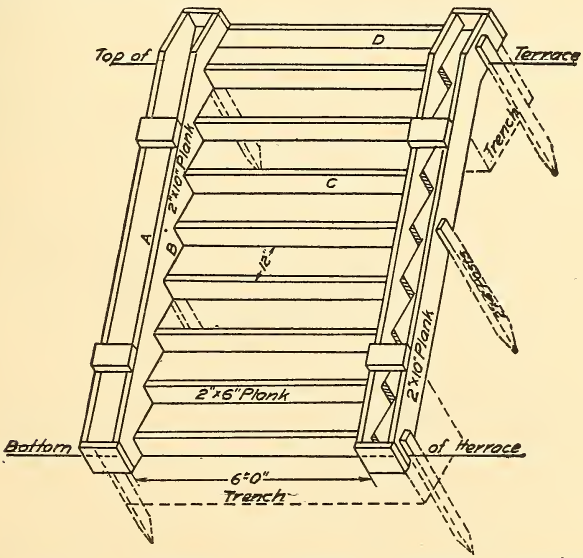
to be hidden from view; otherwise planed lumber is preferable because of the smooth, finished surface that can be secured on the concrete and also because concrete will stick less to smooth than to unplaned lumber.

Generally, air-seasoned lumber is better than green or kiln-dried lumber. Green lumber is likely to dry out after built into forms, causing joints to open and result in leakage of water from the concrete, carrying with it

cement while the concrete is placed. Kiln-dried lumber is likely to bulge and swell up when the wet concrete is placed in contact with it.

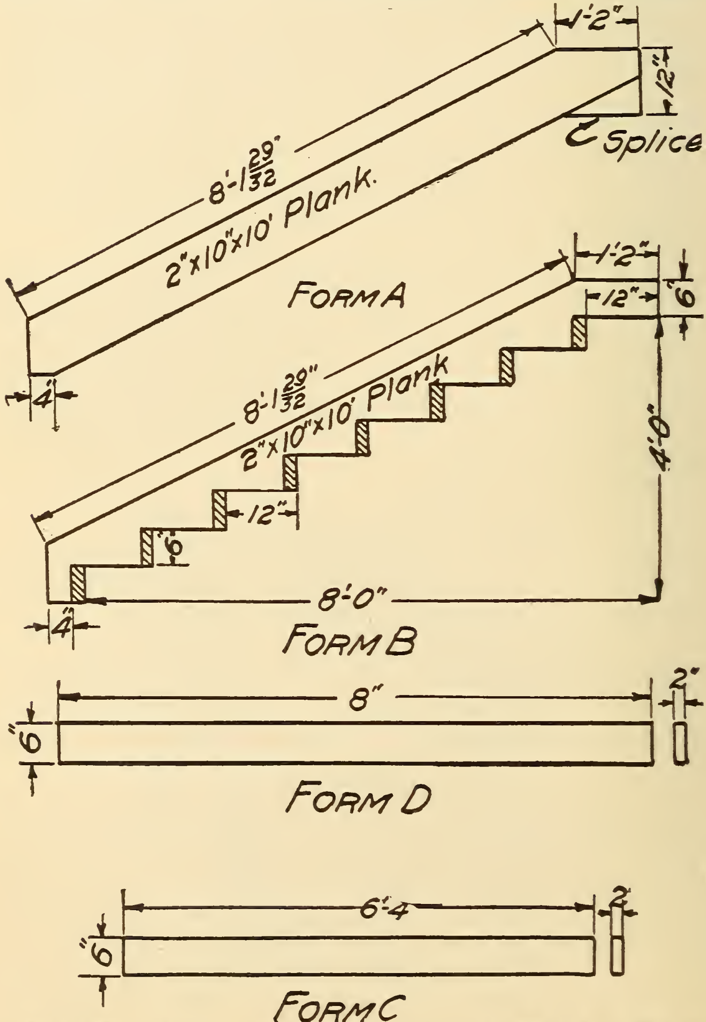
Lumber dressed on both sides and edges may sometimes be necessary because sheathing boards used on forms that are to serve for a concrete surface eventually to be exposed must be of uniform thickness otherwise when nailed to the studs the inside face of forms will be very irregular and this irregularity, due to differences in thickness of the sheathing, will be reproduced on the concrete surface.

Where forms must necessarily be built very tight, tongued and grooved lumber or a stock known as shiplap is often used for form sheathing. Beveled edge sheathing stock has its advantages because if the lumber should swell after the forms have been made, the edges will slip past each other without causing warping or bulging of the boards.



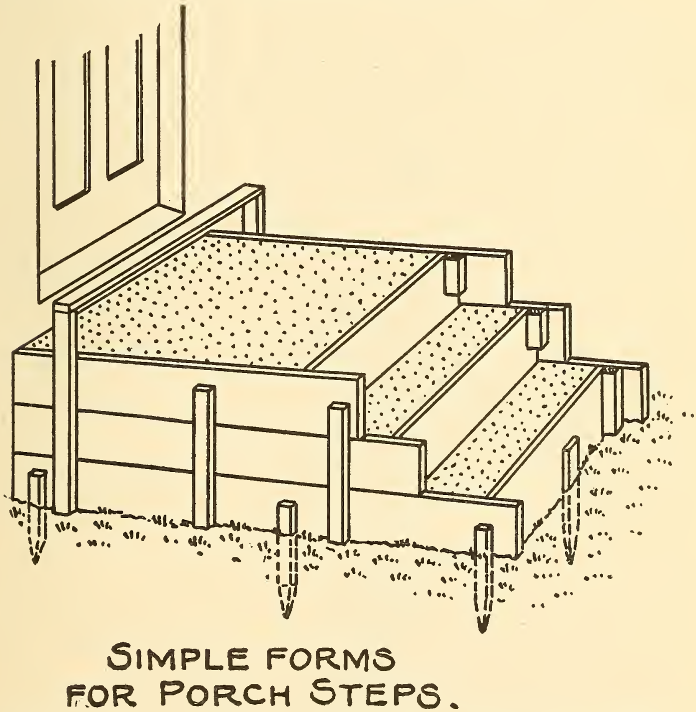
Details of form construction for terrace or similar concrete steps.

When Kiln Dried Lumber is Preferable. In making some small ornamental objects such as flower boxes, kiln-dried lumber is to be preferred, but before used the



Dimensioned details of the various form parts used in cellar or terrace steps conforming to the preceding illustration.

first time, the entire form should be well soaked with crude oil so that the lumber will not swell when the wet concrete is placed against it. This oiling will also prevent concrete from sticking to the lumber and in that way will make it easier to keep forms clean and thus make them serve longer for repeated use.

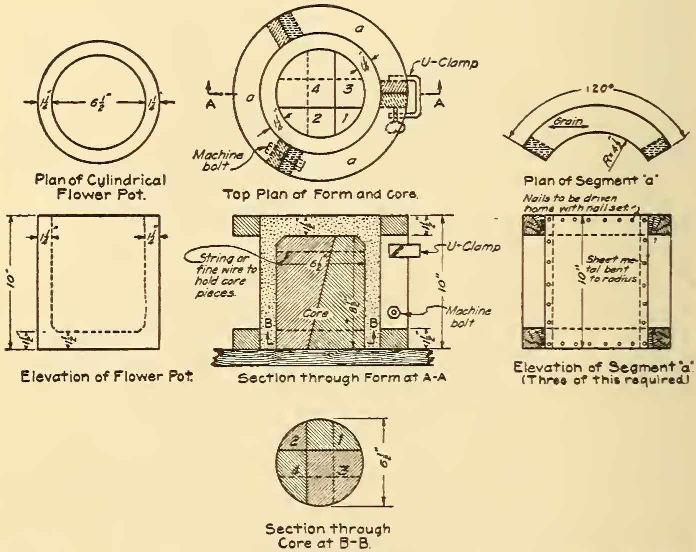


Simple forms for porch step construction showing the manner of staking boards to place.

Thickness and Size of Form Lumber. Depending upon the nature of the work, its massiveness, and hence the volume of concrete to be supported, forms are made of lumber varying from one to two inches thick and of any convenient width. Sheathing boards should be not more than three or four inches wide although if of good,

clear stock, may be six inches wide. The studs and bracing to which sheathing is nailed may be 2 by 4's, 2 by 6's or any larger necessary to withstand the loads or strains that will be brought upon the forms by the concrete in place, before it has hardened and become self-supporting.

Norway pine, spruce and southern pine are the most generally used and economical form lumber. Short-leaf pine also makes good form sheathing. If spruce can be obtained it is probably the best material to use for



Method of making forms and core for casting circular concrete flower pot.

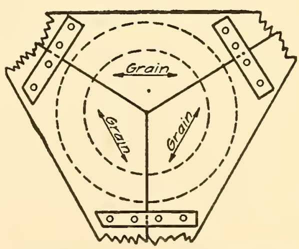
studs, braces, joists and posts as it is tough under bending strains. Hemlock is too coarse grained for sheathing and splits easily, so is not reliable for heavy frame work. Hard woods such as oak are too high priced and too difficult to work economically.

Strong Studs and Braces Necessary. Posts and studs for supporting forms must be strong and stiff enough

to hold them in true line, and to prevent sagging under the load of concrete. Unless they do have this strength, when the weight of the concrete is placed in the forms, gradual sagging will take place and probably continue throughout the hardening of the concrete, thus opening small cracks on the lower side of the concrete surface as it settles. Naturally this will prevent the concrete from having its full effective strength.

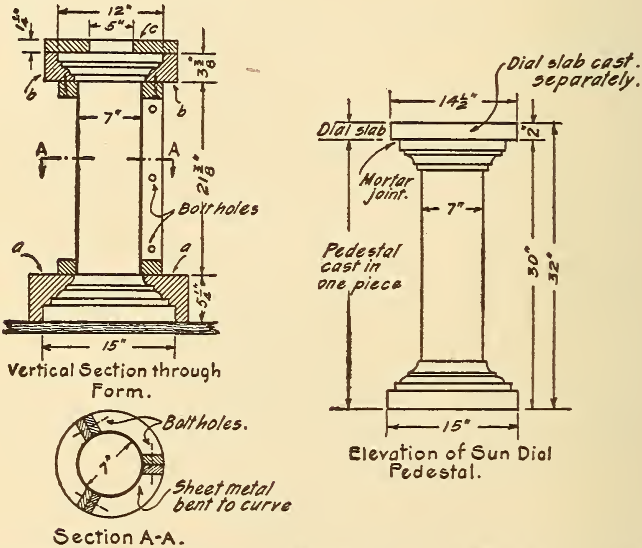
Careful Planning of Forms Pays. Considerable economy in form work results from carefully planning the forms before cutting the lumber. Planning forms involves a careful study of the structure or object to be built. It should be remembered that the face of the form that is to lie against the concrete in place must be built so as to faithfully reproduce the surface as called for by the plans. A projection designed on the structure calls for a depression in the face of the form to produce that projection. In other words, the form face must be the reverse of the concrete face. Often in planning forms they can be worked out in such units or sections as will enable repeated use on similar portions of structures other than the ones for which first planned, or they may be used on various other parts of the same structure. Any such care and forethought given to planning forms will therefore result in final economy of labor and material.

For some work but little cutting of lumber is required. Stock lengths can be used and one end allowed to project so that the lumber will remain serviceable for another and entirely different use. If forms are planned so that few nails will be necessary to hold them



Suggested Method for Cutting Cants with the Grain

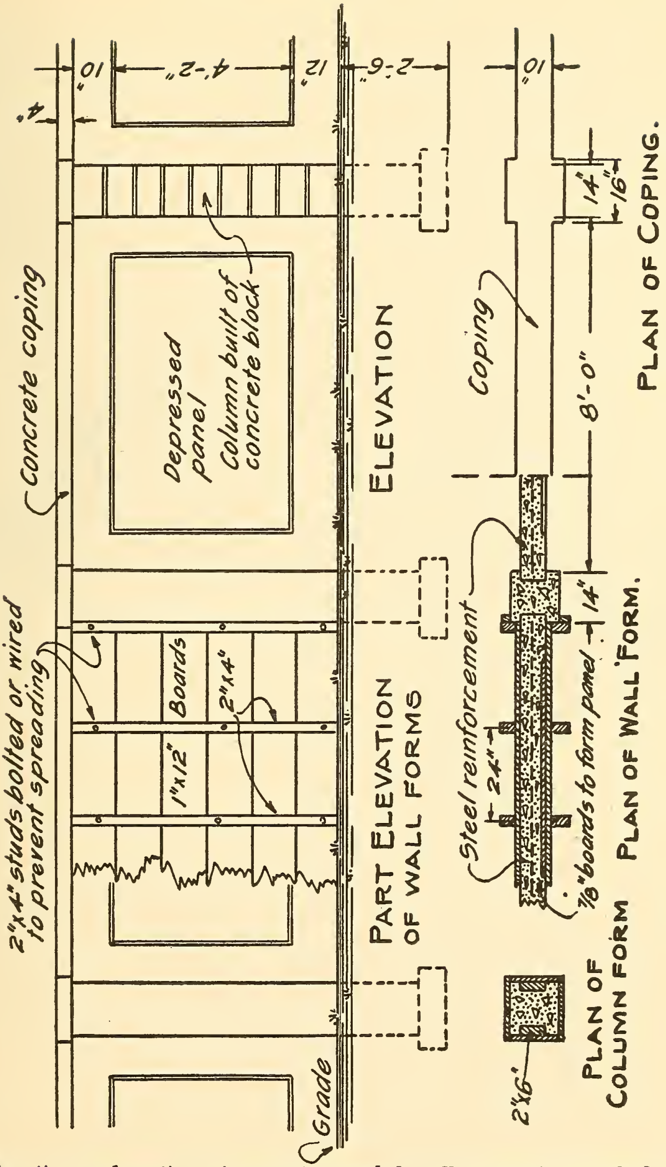
together, less damage will be done to the lumber when knocked apart and less likelihood of damage to the concrete. Often screws, clamps, wire ties and bolts can be used to decided advantage instead of nails. Security, while forms are set in place, is of course desirable but this security can often just as well be obtained with devices other than nails and hence without unnecessary damage to the lumber.



Various details of concrete sundial pedestal showing suggested form construction.

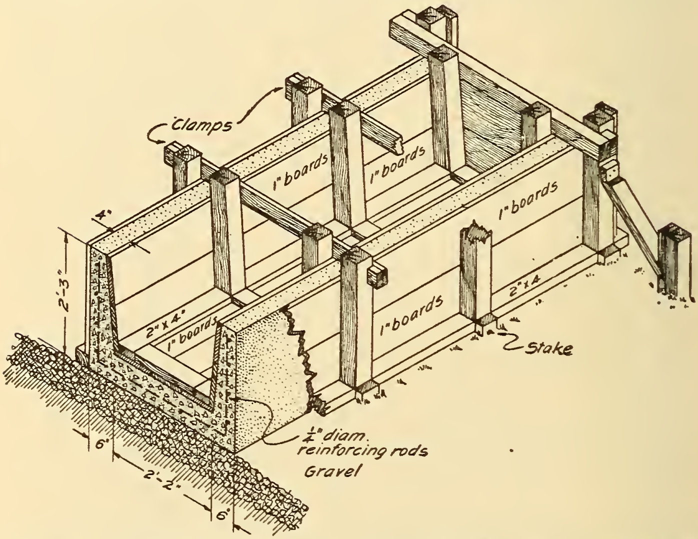
Only average carpenter skill is required to build forms for the common small farm structure. For more important jobs it will probably pay to secure a carpenter to do the form work because he is accustomed to planning for the surfaces to be reproduced better than the novice, therefore he will be careful to avoid unnecessary cutting and waste of material.

Setting Up Forms for Use. When forms are set up in position for use they must be firmly braced by struts



Elevation and section of concrete paneled wall suggesting method of form construction and giving plan of column and coping.

on the outside and held in proper relative position tc each other by braces or spacers placed between and touching opposite form faces. These spacers are usually held in position during the concreting by drawing the opposite form sections together by means of wire ties. Small holes are bored in the sheathing and a wire hoop passed around both forms through these holes and then

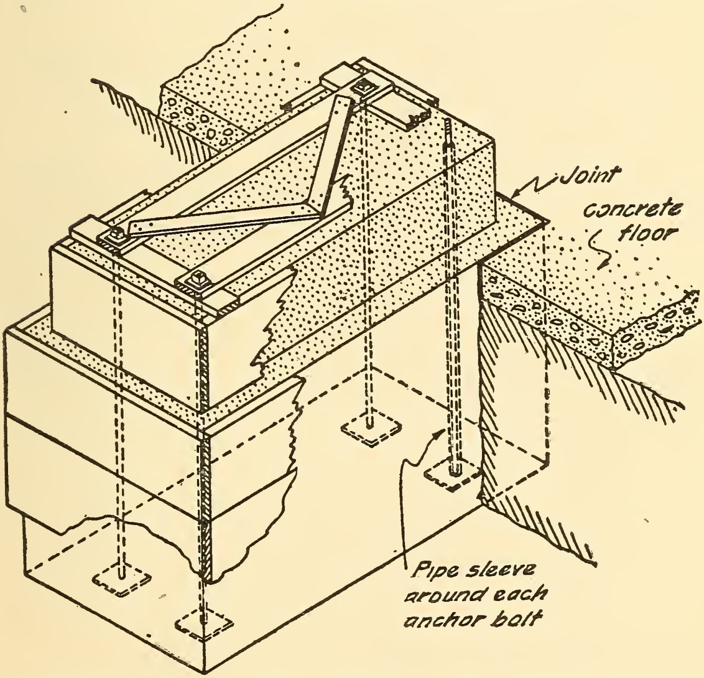


Forms for concrete watering trough illustrating also concrete in place and position of reinforcement.

tightened by twisting between forms. As concrete is placed in forms, the wood spacers holding blocks the correct distance apart are removed. The ties are left in the concrete, the wire being cut when forms are taken down, the projecting ends being cut off slightly back of the face of the concrete and any hole on the surface filled with mortar.

Wetting Down Forms. When forms are set up and firmly braced in position, they should be thoroughly wet down immediately before concrete is placed or if

they are used a number of times, it is best to grease them before set up by painting on a mixture of linseed oil and kerosene or soft soap. Each time after the forms are used they should be thoroughly cleaned before again used and they should also be wet down thoroughly or wiped with an oil soaked rag before placing concrete.



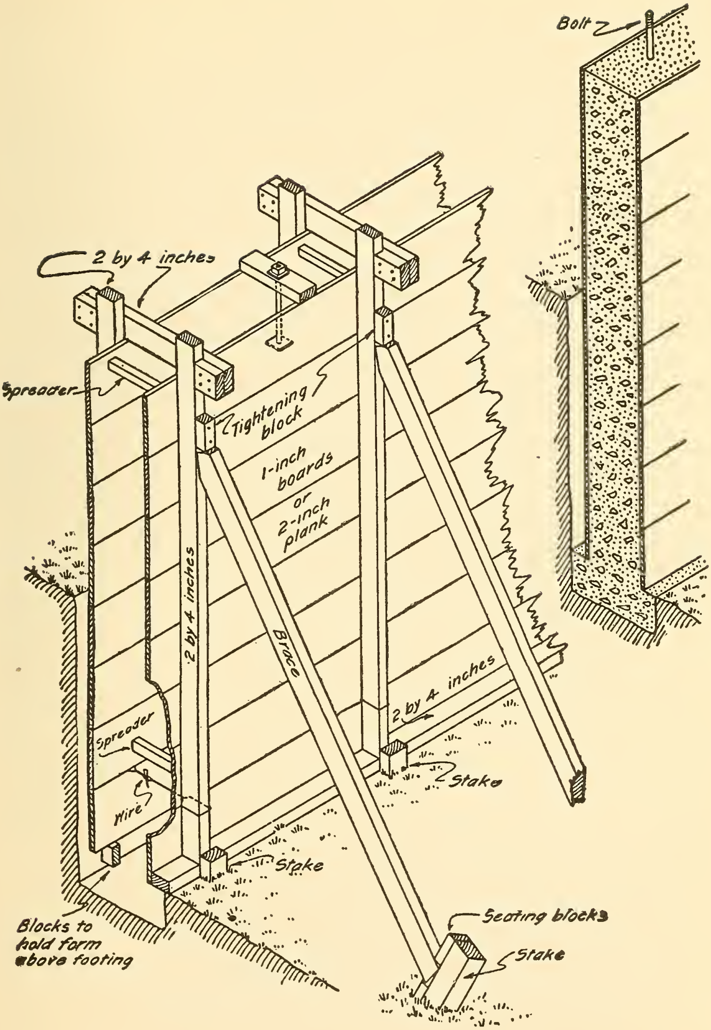
Suggested form for concrete foundation such as would be used for gasoline engine or cream separator. Notice that the concrete floor is laid separate from the foundation. The sketch suggests the templet by means of which rods to attach engine to foundation are suspended in the form while placing concrete. One detail of the sketch shows bolt encased in pipe sleeve. Sometimes this arrangement is used when desiring to fix the bolt firmly afterward by means of molten metal.

Failure May Follow Faulty Forms. Some so-called failures of concrete work have had their origin in faulty form construction. This is particularly true of floors and arches. The form studs or supports were not strong

enough to hold the load of concrete or the entire form was too weak to permit bracing and holding true to line while the concrete was hardening, and hence gradual settlement or change in position of forms has occurred while the concrete was undergoing early hardening, resulting in the small cracks in the concrete already mentioned. These naturally increase in size just as soon as the structure is loaded. They frequently may be sufficient to cause failure immediately after forms are removed.

Form Removal. Some failures of concrete structures have resulted from removing forms from the concrete too early. Concrete hardens quite differently under different weather and temperature conditions and under different conditions of moisture content. That is, a so-called dry concrete and very wet mixture will neither harden as uniformly nor as reliably as one containing exactly the correct amount of water. Moist, warm weather produces conditions most favorable to rapid and uniform hardening of properly mixed concrete. Cold weather delays hardening greatly and in an uncertain degree, depending upon the degree of cold. It might be safe to remove forms in from 12 to 24 hours from some piece of work done in warm weather, while it might be necessary to leave forms in place for two or three days or even more in cold weather.

In general, massive walls that have no load to carry other than their own weight permit form removal earlier than some other portions of the structure. Forms should not be removed from under floors until all danger of collapse has passed, that is, until the concrete is evidently thoroughly hardened. This applies also to roof slabs and arches. No specific rule can be laid down for the exact time which must elapse before forms can be



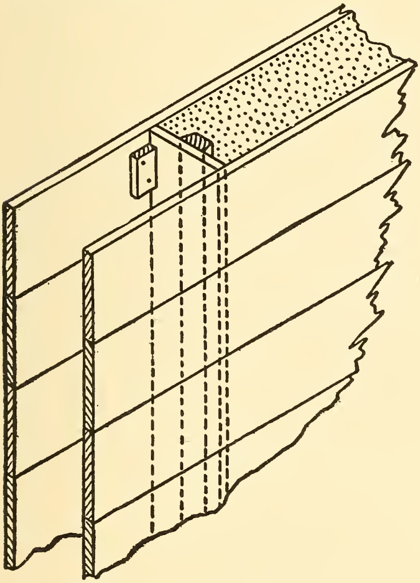
Suugested form for concrete foundation where both outer and inner forms are necessary because of the earth being unstable. The right hand portion of the sketch shows concrete in place with anchor bolt set in the foundation for the purpose of securing wood sill of the superstructure. Various details on the drawing should make the construction clear.

safely removed. This is something that only experience and good judgment can determine.

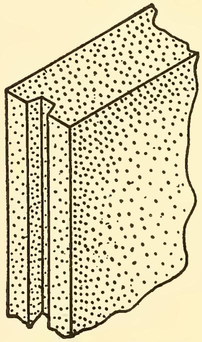
Some Simple Form Principles Illustrated. An example of how important it is to carefully plan forms or molds for some classes of concrete work is illustrated in some accompanying sketches. Division points for circular or irregularly shaped objects must be along such lines as to permit form removal with least resistance or friction that might injure the green concrete. At no point should any section of the form bind or cling to any part of the concrete object as the least sticking to the concrete makes it likely that the surface of the portion will be marred or broken. As an example of this, take a mold intended for a fluted column such as shown in the left-hand sketch on page 39. This column is illustrated as having twenty-four flutes. In this case it is necessary to so divide the form that each section may be withdrawn in the direction of the arrowhead without any binding at any point. In other words, six divisions of the form are necessary. The dotted lines parallel to the direction of the arrowhead show that the form will clear all flutings without breaking the edges. In this particular case the flutings are shallow. If they were deeper a still greater number of divisions of the form would be necessary to permit removing it without injuring the delicately molded concrete edges.

It is always necessary to first lay out a column like this in plan so that by drafting computations one can determine the number of sections required for the form. This particular form illustrated is supposed to be of cast iron. Of course such a form could be made of wood by a skilled wood worker, but it is hardly likely that the average worker in concrete will attempt form construction of this kind. The drawing is given merely as an example of the point to be brought out.

The sketch at the right on page 39 shows in section a form for some concrete product having projecting surfaces such as pilasters or lugs. The form is shown partly filled with concrete to illustrate the object supposedly being molded in it.



Form showing stop board in place.

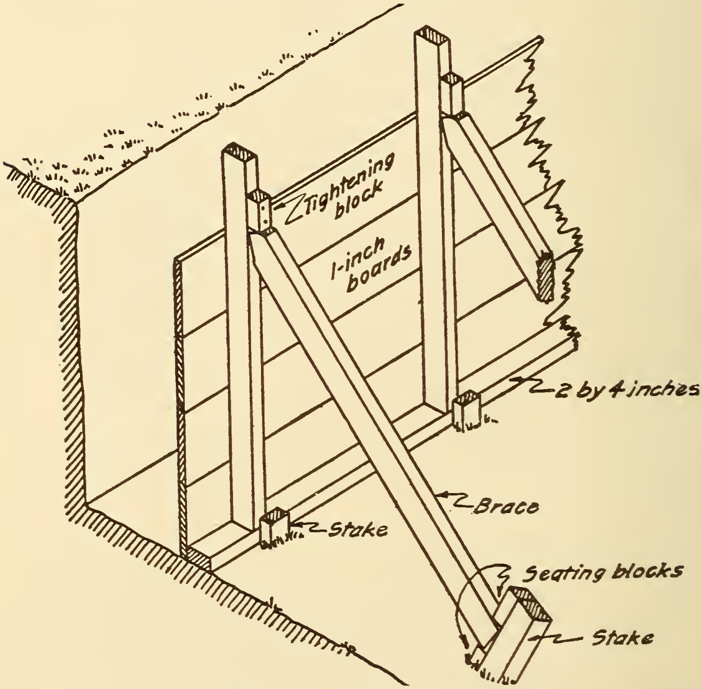


Wall with form removed.

Method of placing stop board in forms when it is desirable to build one section complete to top of forms and leave work in such condition that when the adjacent section is concreted the groove shown in the sketch to the right will be formed in the concrete previously placed so that a tight joint can be made between these sections.

There is a correct and incorrect way for making forms for such objects. Segment e has joints in the middle points of projections 1. When withdrawn in the direction of the arrowhead, the form will clear the concrete as is indicated by the parallel dotted lines ff. This is the correct method if the form is divided into four segments similar to e. If, however, the form is divided into

four segments similar to a, having the joints midway between two projections, the segments cannot be withdrawn in the direction of the arrowhead nor in any other direction without breaking the edges of the projection as shown by the parallel lines bb. If the edges of the projection on the product are parallel with the line drawn



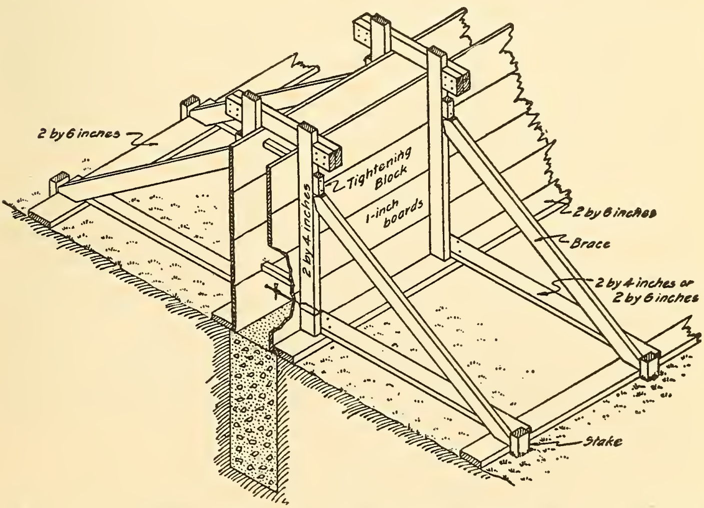
Suggested form for inside face of concrete foundation wall where outside forms are not needed and where possibly the excavation is to be used as a cellar.

through the center of the product, as shown in c, then joints midway between the projections would be permissible and the forms could be divided into four segments similar to c. These segments can be withdrawn in the direction of the arrowhead as indicated by the dotted lines d. If the form were divided into eight parts

then each part would be similar to segments g, which could be withdrawn in the direction of the arrowhead without injuring the edges of projections as is shown by line h parallel to the face of the projection.

Some simple form details are shown in another sketch which illustrates a form for a solid concrete block 9 inches square by 10 inches high. This form may be built of 1 or 1½ inch lumber. The ends of sides b have cleats nailed to them as shown at c. These cleats hold the sides a securely in position while concrete is being placed in the form. The sides lettered b are held in position either by clamps and wedges or by any convenient method.

To prepare for use, the four sides are set up on a work bench or table to which pieces corresponding to d are nailed in position to hold the form secure. Nails used to hold these blocks in position should be driven in only part way so that when starting to dismantle the form



Method of building and setting form for that portion of a concrete foundation above ground where the trench has been made in firm soil thus making forms below ground unnecessary.

they can be readily withdrawn without any violent effort that might injure the concrete.

These are simple form details but their application may be extended to any larger objects since fundamental principles are shown.

Frequently forms made for some cylindrical object are divided along such lines as to divide the object into two supposedly equal parts. An examination, however, will prove that these parts are not equal or true halves. Often the cut is made so that the dividing line is to one side of the true diameter. A sketch on page 44 illustrates this.

The parts a and b shown in the sketch at the left of this illustration are not equal halves because the dividing line was to one side of the true center or diameter. Therefore, when attempting to remove the form section a it will bind, because it includes a circumference greater than half of the circle. This is better illustrated in the center sketch. By far the safest way is to divide such forms into three sections, shown in the right hand sketch, which makes certain that there can be no binding on the concrete face when forms are removed.

A method of cutting wood so that the grain will run the long way of the pieces regardless of their number is shown in a sketch on page 49. The wood is cut into diagonal sections and assembled by cleats screwed to the sections as illustrated. The center is then sawed out along the inner dotted circle to prevent splitting. Pieces of this kind should be of at least 1½ to 2 inches thick lumber.

REINFORCEMENT.

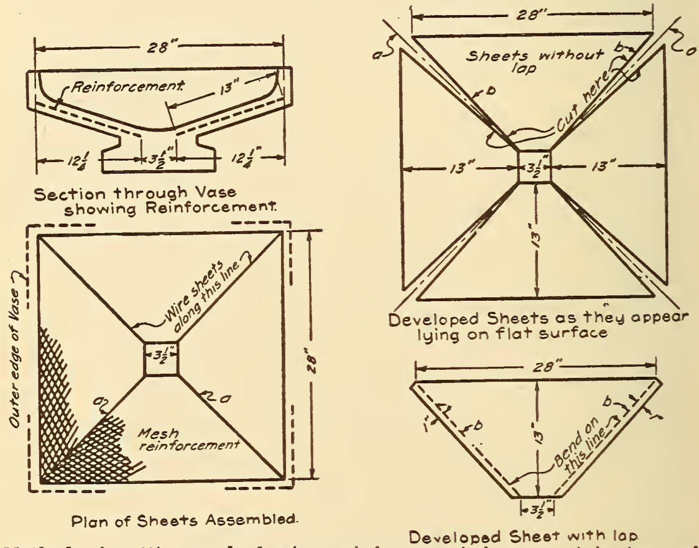
Concrete is either plain or reinforced. Plain concrete means concrete that is placed in forms or otherwise used without any steel rods or other metal embedded in it. Reinforced concrete is concrete in which there is embedded steel rods, wire mesh, metal fabric or some kind of similar materials intended to increase its tensile strength.

Concrete is very strong in compression, that is, in sustaining or bearing a load placed immediately upon it and which does not subject it to any strains other than supporting that load. This refers to loads acting downward on mass concrete like a fountain. Concrete has but little strength in resisting tension, that is, loads or strains that tend to bend it or pull it apart. For example, a cube of concrete, say 1 inch square, would support a large load placed directly upon it. If we take this cube of concrete and increase its dimensions by changing it into a column say 1 inch square and 10 inches high, it might still sustain a considerable load but other strains would be brought to bear upon it because of its length and would break it.

If we took this same column, 1 inch square and 10 inches long and laid it down as a beam, supporting each end and leaving the middle unsupported, it would not carry anywhere near the same load placed at its center as it would standing in a vertical position acting as a column. Again if we took a beam of concrete and fixed it so that it would remain supported at one end only, the other end projecting outward, the beam would not have to be made very long before it would break of its own

weight. The breaking of the beam supported at one end as just described is due to tension or the pulling and bending loads exerted on the concrete.

However, a way exists to take full advantage of the compressive strength of concrete and at the same time make use of its full tensile strength by embedding reinforcement in it. This reinforcement is usually in the form of steel rods which may be round, square, or of various deformed types, or reinforcement may be various



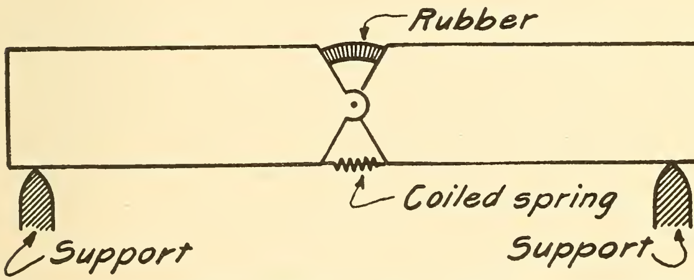
Method of cutting and shaping reinforcement for a certain type of concrete flower urn.

forms of woven wire mesh or fabric, or deformed sheet metal of various kinds which commercially is known by numerous trade names, such as "expanded metal," etc.

Principles of Reinforcing Illustrated. The principle of reinforcing in simple terms is that the steel being strong in resisting pulling strains makes up for this deficiency in the concrete and when placed in the concrete takes all the tension because if the concrete is of the right

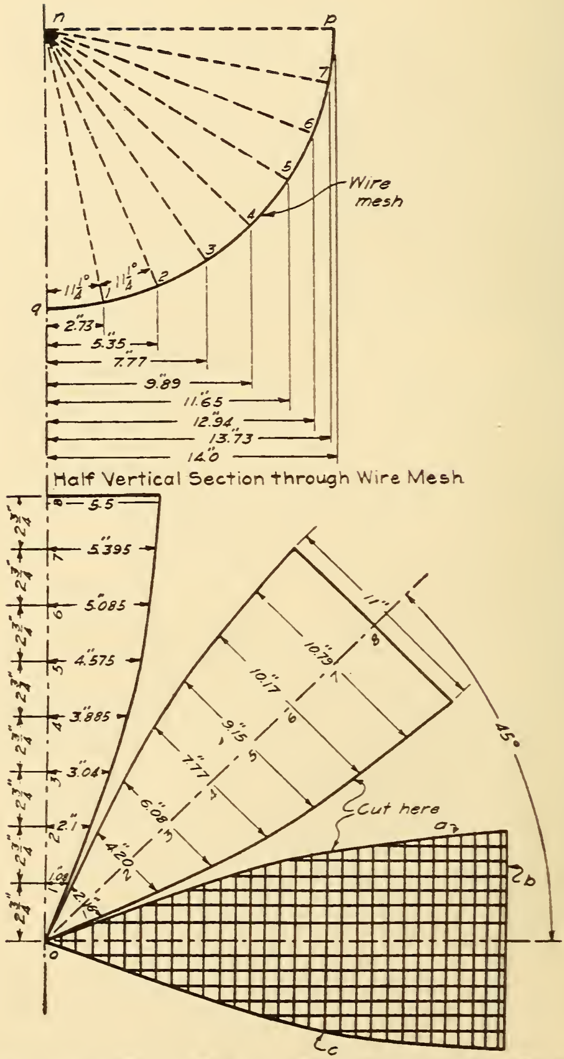
consistency when placed and is properly so as to everywhere surround the reinforcement, it will adhere firmly to it and thus cause the reinforcement to take the pulling or bending strains.

The principle of reinforcing can be illustrated by several simple examples. The accompanying figure is intended to illustrate a beam made of two pieces, connected by a hinged joint, no matter how this joint may be devised. In the opening above the joint is supposed to be a block of rubber. In the opening at the bottom there is shown a coiled spring. This beam, as will be noticed, is



Sketch illustrating the manner in which a load on a concrete beam develops on the beam the forces of compression and tension.

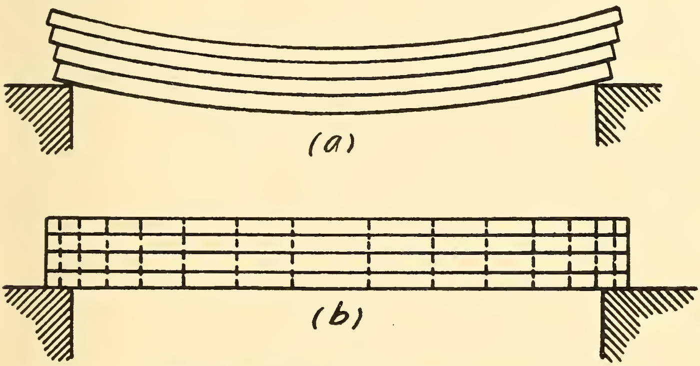
supported at each end but not in the middle. Therefore, when a load is placed on top of the beam it will bend at the hinged joint. As a matter of fact, it is likely to bend at this joint without load other than its own weight, but for purposes of illustration it is not necessary to consider this fact. One can readily see that supported as the beam is at each end, when it begins to bend under load the gap where the rubber is placed will tend to close and squeeze the rubber, thus deforming it as shown in the sketch. This deformation is the result of compression. At the same time the gap at the bottom of the beam will open because of bending under load and the spring will be stretched. The rubber receives the force of compression while the spring receives the force of tension. The



Method of developing a sheet of reinforcement for use in reinforcing a hemispherical concrete object such as a flower vase.

spring being of metal will, of course, tend to resist the tension as much as it can—in other words, will tend to take up this strain and the stronger the spring the greater resistance it will have to bending; therefore, the less bending will take place in the beam.

If the beam were made solid and instead of the coiled spring had a steel rod embedded throughout its length, say ½-inch or more from the lower face, the adhesion between concrete and the steel would compel the steel rod to remain fixed and to resist effectively the tendency of the beam to bend under load. In other words, the steel rod would take up the pulling or tensile strain exerted by the load.



Sketch showing principle of stirrup reinforcement in beams.

Another sketch illustrates the principles of reinforcement further. The upper view shows a number of boards piled one on top of the other with the ends supported. We will suppose these are ½-inch boards 18 or 20 feet long. Anyone who has laid a thin board like this on two supports as shown knows that the board will sag in the center, merely of its own weight. If any load is put upon it, it will sag still more. The same applies if one board be placed upon another—sagging continues. However, if we take these boards before placing them in this

position and bolt them together as shown in the lower sketch, the tendency to sag will be greatly resisted if not entirely prevented. This is because the bolting together prevents the surfaces in contact from slipping past each other as they do when not bolted as shown in the upper sketch.

In reinforced concrete beams, rods with what are known as stirrups properly connected to and extending from these rods up in the beam will take care of the same strains in the concrete as are illustrated at "a" in the planks under load.

Materials Used to Reinforce Concrete. Not every material can be used to reinforce concrete. The principal reason why steel is used, is because steel and concrete expand and contract under temperature changes in almost exactly the same degree. This is very necessary in reinforcing material because if expansion and contraction were not uniform the difference of expansion between reinforcement and concrete would cause the bond between the two materials to break, thereby destroying the effectiveness of the reinforcement.

Steel is placed in the concrete where it will best resist tensile strains. This means that it is necessary that there be determined a correct point or location for the reinforcement to secure its full effectiveness. Great refinements of location are not necessary in some particular cases.

Reinforcement is sometimes used to counteract cracking of long sections of walls, due to expansion and contraction under extremes of temperature. In a beam, reinforcement is placed along its lower section sufficiently embedded in the concrete to prevent exposure to fire. Usually from 1 to 1½-inches back of the lower face is all the protection that is needed although its exact position with respect to furnishing the greatest effective strength

must be determined by the design of the particular section of the structure.

Steel is also protected from rust by being embedded in the concrete because well made concrete is damp-proof and effectively excludes moisture. A column or fence post should be reinforced so that it will resist tension on all sides, because in a fence post as it is in use, pulling strains may come upon it from any one of four directions.

The strains that are brought to bear upon a loaded column may be illustrated in a very simple manner. Take a sheet of tissue paper, form a cylinder from it and fill the cylinder with sand. If handled very carefully the tissue paper will withstand the tendency of the sand to burst the paper, but it requires only slight pressure from one's hand applied to the top of the filled paper cylinder while it is standing on one end to cause the paper to burst, thus releasing the sand. This simple example illustrates the crushing effect of loads on concrete columns. To resist such loads columns must be reinforced. How reinforcement helps can be illustrated by supposing the cylinder just described were made of tin instead of paper. One can readily see that it would require considerable load on top of the sand to burst the tin container encasing it. This partly illustrates the principle of reinforcing columns, which consists of embedding suitable vertical steel rods in proper position, near the corners of square columns and placed at proper intervals inside the circumference of a circular column; then hooping these vertical rods with wire.

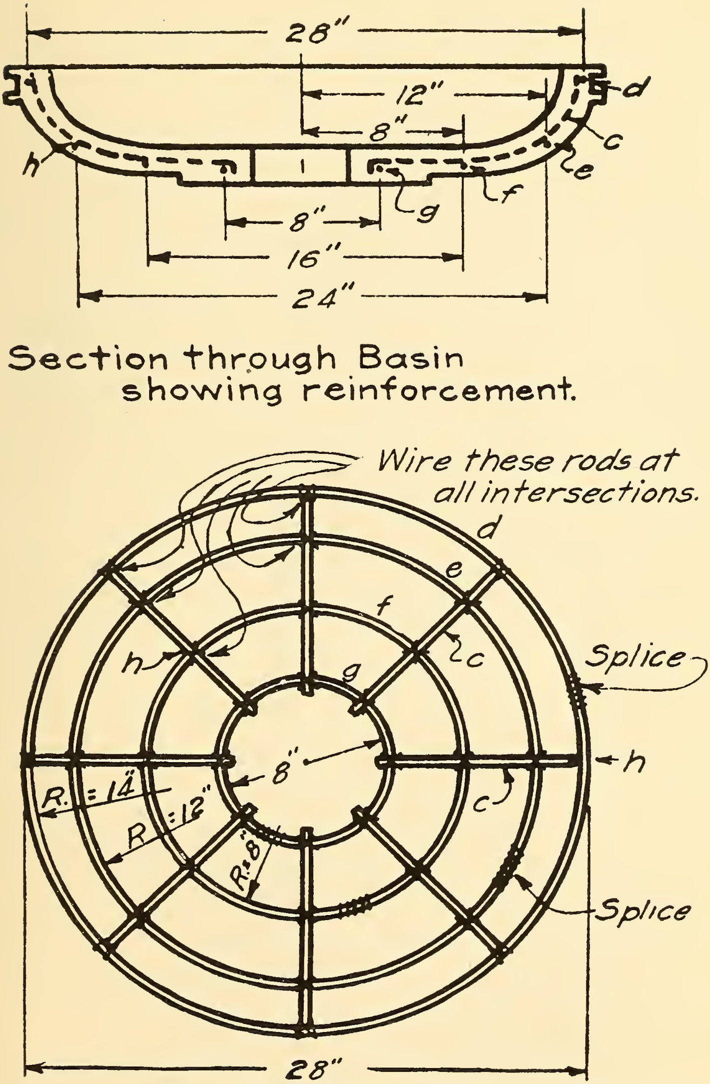
These examples are given merely to illustrate the principles of reinforced concrete since the subject of reinforced concrete design is a very technical one and only acquired after considerable study of the underlying principles of engineering design involved.

As previously mentioned, not every kind of material is suited for reinforcing concrete. This may be further amplified by saying that not every kind of steel is suitable for reinforcing concrete. Generally speaking, various forms of round or square rods or bars are more extensively used in reinforcing concrete than any other material. However, various mesh fabrics and so-called expanded metals are considerably used and they are just as effective if used with proper regard for the tensile strains which must be taken up or counteracted.

Various kinds of patented bars are on the market. Most of these involve some alteration of the shape of the bar, such as forming lugs or projections on its surface when the metal is rolled, and in this way attempting to counteract the tendency of the steel to slip in the concrete; in other words, increasing the mechanical bond. However, tests have shown that if concrete is properly proportioned and placed at the right consistency so that everywhere it is in perfect contact to enable it to effectively bond with the entire surface of the reinforcement, the deformed or patented types of bars have no particular merits to recommend them for choice in the ordinary classes of concrete construction.

Many of the reinforcing meshes or fabrics are not unlike woven wire fence, except, however, that the meshes or openings in them are of uniform size throughout the width and length of the material. So-called expanded metal is made from sheets of steel of various thicknesses, depending upon the use to which the reinforcement is to be put, these sheets being slotted or cut at regular intervals so that they may be pulled apart or expanded, thus increasing their area and thereby forming sort of a lattice-work fabric.

The advantage of many of these expanded or metal fabrics is readily apparent when they are used in con-



Method of assembling rod reinforcement for bowl or basin of concrete bird bath, fountain or similar ornamental object.

nection with stucco or other plastered surfaces. They provide a good bond or key for the cement mortar and are also fireproof. Being thoroughly protected by the concrete they are practically permanent since the concrete prevents moisture from rusting them.

Many of the mesh fabrics or different types of expanded metal are particularly suited to reinforcing small ornamental objects of thin wall sections, such as small troughs, tanks and flower boxes.

Much dissatisfaction with concrete work attempted by the novice or beginner has resulted from the belief that almost any kind of scrap metal such as barbed wire, chain, old pipe, etc., would do for reinforcing. This is not true. Only material intended for reinforcment should be used as such. Steel for reinforcing, either in the form of rods, mesh or fabric, is supposed to have a certain chemical composition, resulting in giving it a certain strength and other properties. For that reason it is not likely that rods that may be obtained from the local blacksmith, for example, are either the best or cheapest.

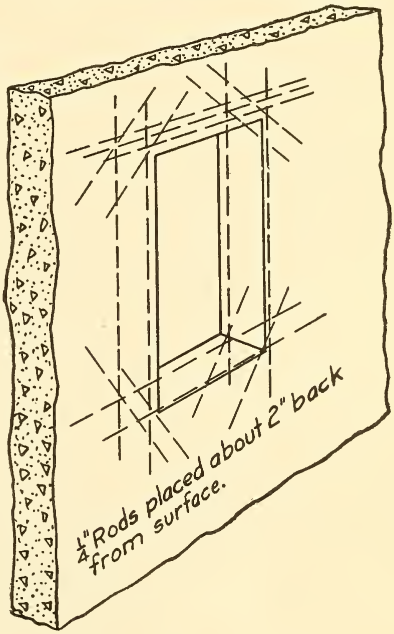
Naturally rods and the various other kinds of reinforcing material are limited as to length of pieces. Therefore, in use it is necessary to splice reinforcement to make it continuous where so desired. Ends of mesh should be lapped 4 inches or more and bound together securely by wires. A good rule for lapping rods is to lap them from 50 to 60 times their diameter.

Rods and other reinforcing material must be handled properly. Rust or mill scale should be removed from it by brushing with a wire brush before placing in the forms to be embedded in the concrete.

It is necessary to bend rods and mesh to conform to certain shapes of the structure. Reinforcement should not be bent suddenly. Frequently this will cause frac-

ture. It should be shaped gently and by exerting a uniform steady strain until it has been given the proper lines.

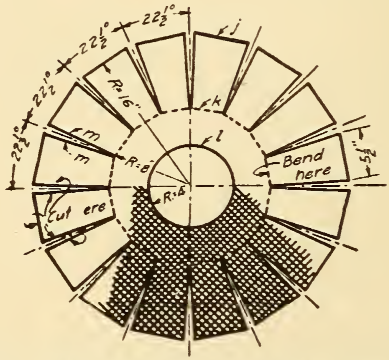
Planning or Laying Out Certain Reinforcement. Whenever expanded metal or wire mesh is used to reinforce small objects, such as flower boxes, bird bath basins, fountain bowls or small tanks or troughs, it is necessary to cut the flat sheets so that the reinforcement can be bent up and joined to conform to the general lines of the product. This is called developing the sheet of reinforcement. For example, in order to have the reinforcement for the basin of the fountain as shown on page 117 conform to the shape of the basin, it will be necessary to cut the flat sheet as shown in the accompanying illustration. After the necessary cuts have been made, the sheet should be bent along the dotted lines as shown, and the laps securely wired together with black stove wire. The greater the diameter of the bowl to be reinforced the greater the number of radial cuts required to enable shaping the reinforcement properly.



Method of placing reinforcing rods over window and door openings and at the corners of such openings when made in a concrete wall.

A sketch on page 64 shows a convenient method of laying out developed sheets for bowls that are not so flat as the fountain bowl just referred to. In this case the flat

sheet consists of eight equal sectors although the part sketched shows only 2½ of these. When these sectors are bent up so that their edges meet, they form a hemisphere. The length of this flat sector along the center line is equal to the length of the arc of a circle shown in the upper part of the drawing. In this example it was found convenient to divide the sector into eight equal parts each 2¾ inches long. The 90-degree vertical arc is also divided into eight equal parts, the length of each being 2¾ inches as measured on the circumference. The dimension at the outer edge of the flat sector is 11 inches



Method of cutting mesh reinforcement before bending it to proper position to conform with general shape of the object.

or ⅛ of the circumference at the outer edge of the reinforcement at p, when the sectors are bent into the form of a hemisphere.

A practical and simple illustration of developing these sheets may be had by taking an orange and cutting it in half, then making cuts from the diameter down to the stem end, removing the peeling and laying all of it flat on a table. This illustration is a counterpart of the sketch shown and described.

LIST OF CONCRETE MIXTURES AND CLASSES OF WORK FOR WHICH RECOMMENDED

1:1:1 Mixture. This mixture is sometimes used as the wearing course of floors subjected to heavy traffic and where steel tired vehicles must use it frequently. Greater wear is obtained from such a mixture by using, if possible, an aggregate consisting of granite or trap rock.

1:1:1½ Mixture. This mixture is used for the top course of two course driveways and similar pavements in which the pebbles or broken stone are graded ¼ to ½ inch. As a rule neither this nor the first mixture will be found necessary in the average farm concrete work although where the classes of concrete construction referred to are subjected to heavy traffic such mixtures will insure better wearing qualities of the concrete.

1:2:3 Mixture. Concrete roofs on silos, icehouses, and other farm buildings where concrete roofs are used are generally made of this mixture. It is also used for one course walks, floors, driveways, alleys, fence posts, sills and lintels, watering troughs and tanks, and for other work requiring dense strong concrete. Cisterns and foundation walls that are to be more or less continually subjected to ground water and which must resist its pressure may best be built of this mixture.

1:2:4 Mixture. This is the mixture most commonly used for such classes of reinforced construction as walls, suspended floors, beams and columns. Sometimes it is possible to use a 1:2:4 mixture for practically all of the work for which a 1:2:3 mixture is recommended but in

making this substitution it is very necessary to determine that the materials are well graded and that a dense concrete will be secured. A 1:2:4 mixture is also used for bridges and culverts, for the foundations for machinery such as cream separators, gasoline engines and for concrete work that is generally subjected to the strains of vibration.

1:2½:4 Mixture. This is a common mixture to use for silo walls, grain bins, plain building walls above foundation when stucco finish is not to be applied, walls of pits, or basements subjected to considerable exposure to moisture but practically no direct water pressure, manure pits, dipping vats, hog wallows, backing of concrete block that are to be finished with a special facing mixture and for the base of two course driveway pavements.

1:2½:5 Mixture. This mixture is commonly used for walls above ground which are to have a stucco finish. It is sometimes used in foundation work but is generally a richer mixture than is required for the average building foundation except where the foundation wall must form a tight enclosure. It is also used for the base of two course sidewalks, feeding floors, barnyard pavements and other two course plain floors laid immediately on the ground.

1:3:6 Mixture. This is used for mass concrete such as retaining walls of heavy section, for heavy foundations such as a barn would require and for heavy footings.

Cement Mortars. Mixtures such as 1:1, 1:2, 1:3 as has already been explained, are generally used to designate mortars. Such a mixture implies that there is no coarse aggregate, in other words, that there is nothing used but cement, sand and water.

1:1½ Mixture. This mixture is used as inside plastering of water tanks, silos and bin walls where such plas-

tering is necessary, and for facing outside surface of walls below ground where necessary to afford additional protection against the entrance of moisture. As a rule plastering of a concrete surface is not to be recommended. Necessity of this should be prevented by mixing the concrete of correct consistency and properly spading it against form face when placing.

1:2 Mixture. This mixture is used as a scratch coat on exterior plaster work as stucco. It is also used as a facing mixture with selected aggregate for concrete block and similar concrete products. Sometimes it is used as a wearing course for two course walks and floors like barnyard pavements and feeding floors, but such construction preferably should be of the one course type.

1:2½ Mixture. This mixture is used as the intermediate and finish plaster coats on stucco work. It is sometimes used for making fence posts when coarse aggregate is not used, but it makes fence post construction unnecessarily expensive and therefore should be used only when suitable coarse aggregates cannot be obtained.

1:3 Mixture. Concrete block and concrete brick are made of 1:3 mixture. It is also used for concrete drain tile and pipe when coarse aggregate is not used. Ornamental concrete products are generally made of 1:3 mixture. In this connection it may be well to mention that in many ornamental products the minimum size of coarse aggregate cannot exceed ½ inch because of the very thin sections in which concrete must be placed.

The foregoing table of recommended mixtures is somewhat of an arbitrary one. The mixtures are recommended for the various classes of work listed because they have been found satisfactory under average conditions. They are all safe mixtures to use where it is not possible to

make scientific tests to determine whether or not a leaner mixture might be used, providing the aggregates possess the required grading. As these facilities are not within the reach of the average worker it is always best to be on the safe side and place reliance on these recommended mixtures.

PLACING CONCRETE

On large engineering structures there are a number of ways in which concrete may be placed in the forms after mixing. The home worker, however, usually cannot make a profitable use of most of these methods, nor is it desirable that he should use them. For the average structure, placing concrete is merely a matter of transferring it from the mixing platform to the forms by means of shovels, buckets or wheelbarrows.

Place Immediately After Mixing. Concrete begins to harden within a comparatively short time after the mixture has been completed, so the mixed concrete should be placed in the forms or molds as soon as possible. It will usually be found convenient to move the mixing board to different locations on the job so that concrete may often merely be shoveled direct from the board into the forms, as when a concrete foundation is being placed. When the concrete is being placed in the foundation trench, it is well to lay boards or planks along and across the trench, especially if no forms are being used, so that fresh earth will not be knocked into the concrete. All concrete work should be so planned that the quantity of concrete to be placed during a working day or whatever time is set aside to the work, can be estimated with such accuracy that when quitting time comes the job may be left in condition suitable for resuming concreting later.

Depth of Layers. Concrete should be deposited in layers of uniform thickness throughout the enclosure formed by the forms. From 6 to 8 inches is the greatest depth that should be placed at one time, the reason for this being that in spading or tamping the concrete it is

not possible to spade clear through a layer of any greater depth, making certain that it will bond or unite with the layer previously placed.

Sometimes the concrete is placed so as to complete various sections the full depth of the forms or full height of the concrete section being built, thus making the work on that section practically continuous; in fact, it is best to arrange for as continuous concreting as possible, because in this way the construction seams necessarily formed where one day's work stops and another begins, will be fewer in number.

Tamping and Spading. For some foundation work concrete is mixed to merely damp earth consistency. In placing such concrete, vigorous tamping is necessary to insure greatest possible density. Where concrete containing more water is being placed, that is, concrete of a quaky concrete is spaded or puddled in the form. This the mixture does not permit tamping, as blows from the tamper would dislodge the concrete. Therefore, the quaky concrete is spaded or puddle in the form. This settles it to utmost density and in doing so releases air bubbles that may be entrapped in the concrete. Spading next to form faces is very important, because it produces a dense surface, forces back the particles of coarse aggregate and thereby allows the sand cement motar to flow next to the form face and as a result produces a smoother, more uniform surface. Another reason is that thorough spading increases density and hence watertightness.

Tool to Use for Spading. For average use a spading tool may very conveniently be made out of a piece of hardwood board, 6 inches wide and 1 inch thick, shaped to have a chisel edge at the lower end and cut away at the upper end to form a convenient handle; or an old garden spade may be flattened out, or an old garden hoe can be

converted into a spading tool in the same manner. Narrower spading tools are needed sometimes when working the concrete around reinforcement and in narrow spaces.

Variations in Methods Due to Class of Work. Naturally the method of placing concrete will vary slightly, depending upon the nature of the work. For walks, floors and similar pavements the concrete is usually wheeled from the mixing platform in wheelbarrows, or shoveled into and dumped from buckets on the spot where it is to be leveled off. In the case of troughs and watering tanks, the operation of concreting should be as continuous as possible to prevent construction seams. The floor or bottom of a watering trough or tank is concreted to half the depth of the floor, then reinforcement is placed, the inside form quickly set in position and fixed in proper relation to the outside form, and concreting resumed before that concrete first placed can commence to harden.

Between narrow forms concrete should be placed in thinner layers because of the difficulty of spading in the narrow space. Also under such conditions only one form section should be boarded up the full height so that the other may be boarded up as concreting progresses. If this is not done, the depth in the forms will be too great for spading. Another precaution that must be taken is not to allow concrete to drop through too great a height when placing. From 6 to 8 feet is the maximum distance through which it should be dropped. If allowed to fall through a greater distance, there is certain to be more or less separation of materials, which results in the formation of pebble pockets.

Completing a Part Section. Sometimes it is necessary that a certain section of wall, for example, be finished complete to the top of the forms within a definite time. In such a case the next section like it will not join with

the first properly unless some special provision for joining is made when placing the first section. This is easily done by blocking a board in the forms with a beveled 2 by 4 or similar strip nailed to the face of the board against which concrete is being placed, to leave a vertical mortise in the end of the wall. Then when concrete is placed in the next section the board stop is taken out. The concrete previously placed acts as an end form against which the fresh concrete is placed, which forms a tenon fitting in the mortise, arranged for by the 2 by 4 as above described.

Leaving Work in Proper Condition to Resume Concreting. In spite of the desirability of arranging for continuous concreting, it is rarely possible, especially on large structures, to carry on the work uninterruptedly. For this reason it is necessary to leave the work of one day in such condition that it will be easy to resume concreting the next day without leaving any objectionable joint or defect where the two days' work join. To provide for this the concrete last placed in the form should be left slightly rough by scratching with a stick and when concreting is resumed the next day this roughened surface should be washed off and given a coat of cement water paint. With this precaution taken there will be little evidence of the construction seam and leakage through the joint will have been prevented.

CONCRETE FOUNDATIONS AND CONCRETE WALLS

Concrete the Ideal Foundation Material. Every building possesses two parts common to every other building—foundations and walls. Concrete is the home worker's ideal building material for both. The very ease with which it may be made to fill any kind of excavation simplifies foundation construction by comparison with any kind of masonry. The work can be done rapidly and with relatively unskilled labor and as concrete has great compressive strength it makes an unequaled foundation for any building. As a matter of fact, concrete is about the only foundation material used today, regardless of the material used in the superstructure. Of course different kinds of foundation work require slightly different planning and construction details. For example, a foundation that might do for a small dairy building would not do for a heavy barn. Soil conditions vary in different localities. It is therefore necessary to know something of the possible supporting or bearing capacity of the soil so that the foundation may be planned and laid in accordance with the soil on which it is to rest and the load which it is to carry.

Footings. Where soil conditions lack the best supporting capacity, a foundation wall is usually started on a footing if the load to be supported is more than the average. A footing is a wider section of concrete varying in thickness to meet conditions, laid in the bottom of the foundation trench on which the foundation wall proper is started. For example, the foundation wall may be 6 inches thick, while the footing would be a section of

concrete, say, 12 inches wide and 8 to 10 inches thick so that through the footing a greater area of soil would be covered and the load of the building distributed over this greater area by the footing. For barn walls a footing 2 feet wide and 12 inches thick is generally sufficient. For buildings the size of the common house a footing 18 inches wide and 12 inches thick is a fair average, while

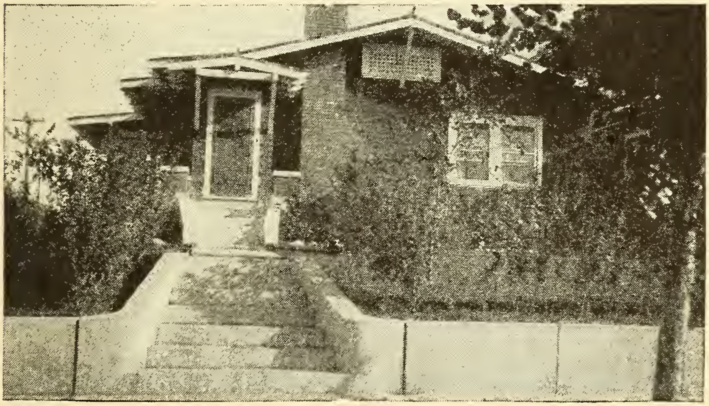
Attractive concrete block wall or fence enclosing home grounds.

footings 12 inches wide and from 8 to 10 inches thick will serve for small farm buildings such as hog and poultry houses.

Wall Thickness for Some Typical Farm Buildings. As it is not always convenient to determine the actual bearing capacity of the soil, the common practice is usually to lay a footing anyway just to be on the safe side. As 6-inch walls are usually the maximum for small

farm buildings such as dairy, poultry and hog houses, a 10-inch footing for the foundation may be considered wide enough. Wall thickness like foundation thickness is governed by the character of the building that is to be supported. Twelve inches is generally safe for basement barns. For the average residence and small barn, a 10-inch wall is usually sufficient, while for smaller structures 8 or 6-inch walls will answer.

Reinforcing Walls and Openings in Them. Eight-inch concrete walls and those of lesser thickness should be reinforced above ground with ⅜-inch round rods



Concrete steps and concrete retaining wall for terrace.

placed at the center of the wall, spaced 2 feet center to center vertically and horizontally. For walls thicker than 8 inches, two such sets of reinforcing should be used, one set 2 inches from the exterior face and one set the same distance from the interior face of the walls. Extra rods should always be placed parallel to the sides of door and window openings and 2 or 3 rods should be placed diagonally at each corner of door and window openings. Ordinarily foundations need no reinforcement.

Concrete Mixtures for Walls and Foundations. Heavy walls below ground may be made of concrete mixed in the proportion of 1 sack of portland cement to 2½ cubic feet of sand and 5 cubic feet of clean pebbles or broken stone. Sometimes a 1:3:6 mixture will answer but the richer mixture should always be used where the wall is to enclose a cellar or basement which it is particularly desired should be kept dry. Walls above ground should be 1:2:4 or 1:2½:4.

Concrete block barnyard enclosure wall.

Concrete Should Not Be Dropped Through Too Great Distance. Care should always be taken when placing concrete in wall or foundation forms not to drop it through too great a height as this will cause a separation of materials as mentioned in another section on the placing of concrete.

Protection of Finished Work. It is very important that concrete walls be protected against drying out after the concrete work has been finished. Because they expose a large double surface area to sun and wind, it is best to leave forms in position a few days longer than actually necessary from the standpoint of safety to the

concrete and to keep all of the work thoroughly wet down.

Extra Rich Mixture Where Soil Is Wet. Sometimes it will be found necessary, because of soil conditions resulting from a constant surplus of water in the soil, or due to temporary rising of ground water level, to use a 1:2:3 mixture for foundation wall construction in order to make certain that the wall will be watertight.

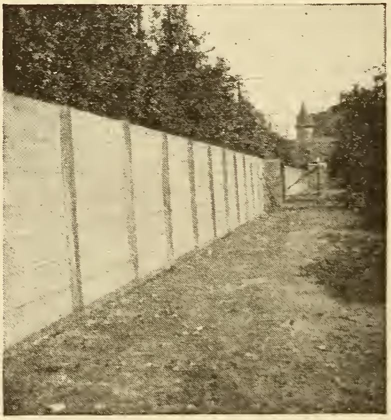
Method of laying out a square corner for a concrete foundation photographically illustrated.

Depth of Foundation. Excavations for foundations should in all cases extend far enough below ground level to reach firm soil and also to be beyond all probable disturbance due to upheaval from frost. If not placed with regard to these conditions cracking of the walls may result.

Form Construction. Form construction is of the simplest and for that portion of the foundation below

ground, forms will not be required, provided the excavated trench has firm earth walls.

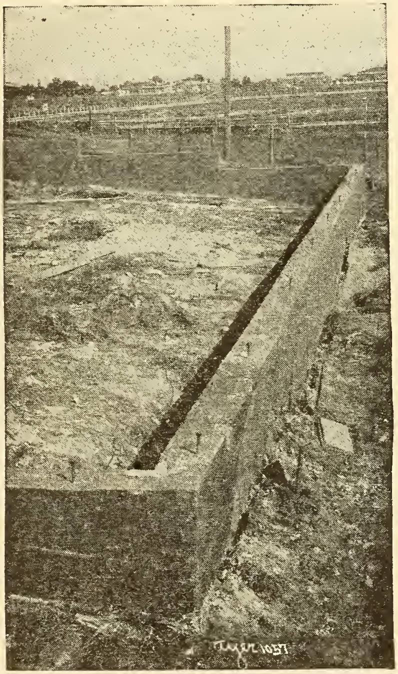
Since the foundation wall must correspond to the lines of the interior of the building, it is very necessary that the foundation be carefully staked out. This is a very simple matter and is illustrated in an accompanying picture and sketch. A stake is set where it is desired one corner of the building shall fall. From the stake a string is stretched to another stake set at a position and distance corresponding to another corner on the same side



Concrete panel wall. The posts serve to give the pilaster effect. This wall is built of precast units like boards.

of the building. From this second stake a string is stretched to a third stake to be set at a point corresponding to the length of this side of the building. Before setting the third stake, however, it is necessary to square up the corner at the location of the second stake. This is done by measuring off a distance of 8 feet from the center of the second stake back toward the first stake and setting a pin in the string at this 8-foot point, and then a distance of 6 feet is measured from the center of the second stake along the string toward the third stake and

this 6-foot point marked in the same manner. The person holding the third stake then moves it back or forth to the right or left as may be necessary, keeping the string tight meanwhile until the distance between the two pins where they are stuck in the strings is exactly 10 feet. The third stake should then be driven. The

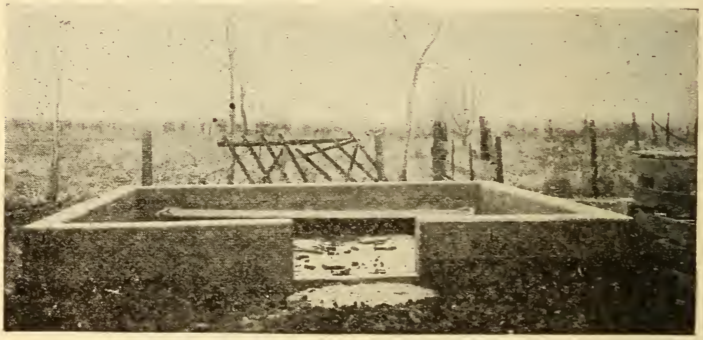


Concrete foundation with anchor bolts for sill in place.

corner marked by the third stake can be squared in the same manner and so on.

Brace Forms Well. Forms for walls should be well braced because unsightly bulges on the surface will result from the weight of wet concrete spreading forms unless they are firmly braced.

Drainage Around Footings. In soils that are not naturally well drained it is sometimes necessary to lay a tile drain at the bottom of the foundation trench leading to some natural outlet, otherwise a house cellar, for example, may be damp at certain seasons of the year owing to water leaking into the cellar because of a faulty construction joint in the wall when concrete was placed or because the joint between floor and wall was not properly sealed. If concrete is properly proportioned and placed



Concrete foundation complete ready for the superstructure.

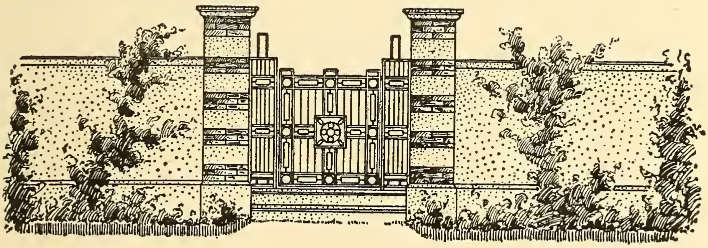
at right consistency, this trouble will not be encountered, so the only excuse for laying a drain as suggested is to prevent a possible happening due to faulty workmanship or the omission of some detail.

Careful Placing of Concrete. On concrete wall work above ground, it is necessary to use a great deal of care in building the forms so that the exposed concrete surface will have a pleasing appearance when forms have been removed. Except only when it is intended that some after-treatment shall be given to the surface, such as a coat of stucco, for example, slight irregularities in the surface do not make much difference. These can readily be removed or rubbed down by going over the

surface in one of the several ways described under surface finishes.

Usually when placing concrete for walls that are afterward to be stuccoed, the concrete is not so thoroughly spaced next to the outside form face but merely against the inner form face and between forms, thus intentionally allowing a few pebble pockets to exist on the outer wall surface so that through these a better bond or key will be secured for the stucco plaster.

Concrete walls besides forming a part of a building, for example, are used to enclose barnyards and feeding lots, are used to hold back the earth of a terrace, or may serve to line an excavation that is intended to be used as a reservoir, etc.



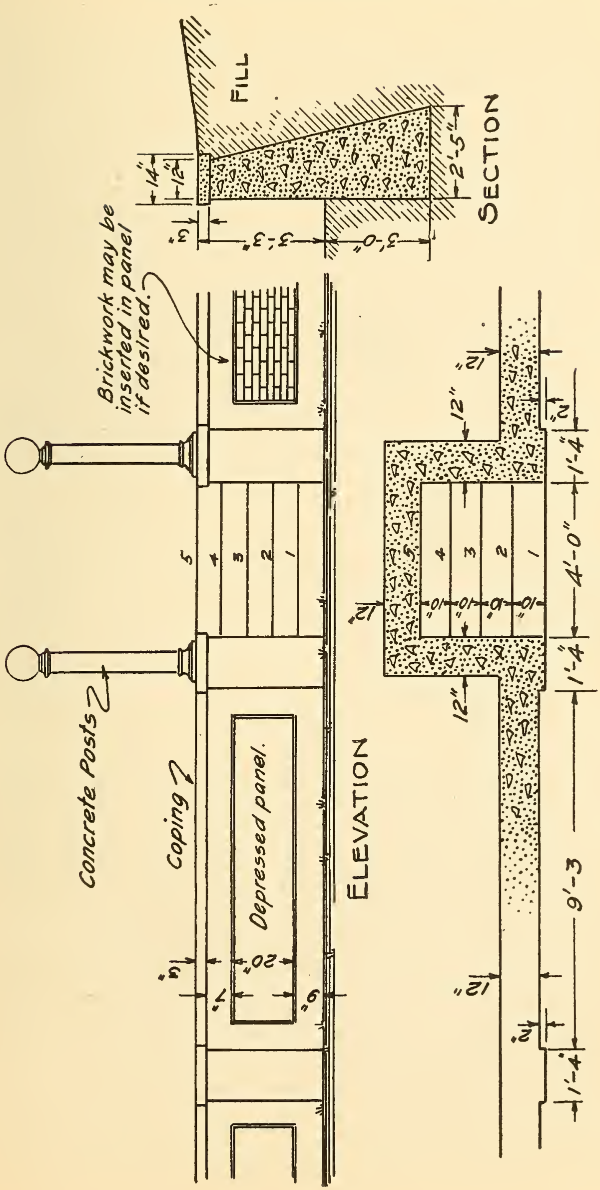
Sketch for concrete gateway posts and monolithic wall.

Variety of Concrete Walls. Concrete walls may be considerably varied in appearance, depending upon how they are built. They may be of monolithic concrete, which in turn may be plain or reinforced. They may be of concrete block, either solid or hollow, or they may be of precast units like slabs, or they may even be of units exactly like those employed in building cement stave silos. In fact, one of the recent extensions of use for cement silo staves is to build walls for small farm buildings. A number of poultry barns and hoghouses have been built in this way. While monolithic walls used as enclosures may be either plain or reinforced, it is usually

economical to reinforce them because by so doing, thinner sections of concrete can be made to serve the same purpose and the reinforcement does not cost as much as the saving made possible by using the thinner reinforced sections.

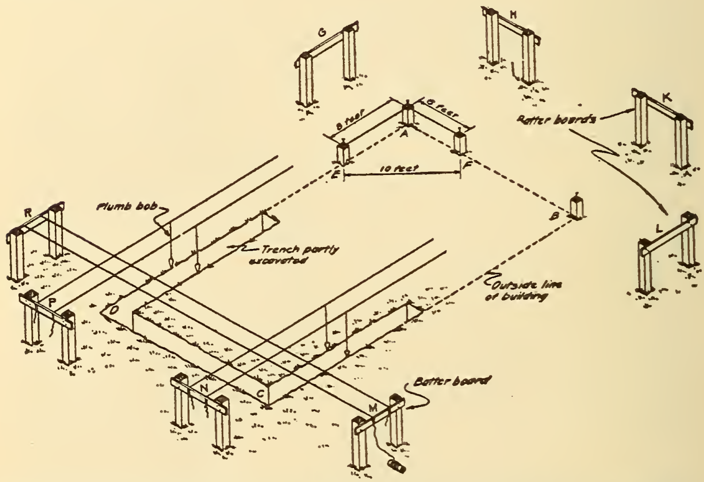
Except for the building of forms intended to give added ornament to a wall, form construction is simple and requires practically no skilled labor. Lumber used for wall forms if carefully handled can readily be made available for some other purpose as it is rarely necessary to cut stock lengths except to make them of uniform length, so the lumber is not injured and hence the actual cost of building forms with respect to the wall alone is not great.

Concrete block walls, as the name implies, are laid up of precast block just as any other jointed masonry construction is laid. Such walls while attractive are necessarily less substantial than those built of monolithic concrete, particularly of reinforced monolithic concrete. Any unequal settlement of a block wall is certain to result in unsightly cracks opening up the mortar joints, the repair of which is difficult as far as concealing the defect goes, and the fact that the wall has settled out of line will always attract attention to this evidence of faulty workmanship. However, such happenings can be prevented by carefully building the foundation of the wall and making certain that settlement will be safeguarded against by providing a footing sufficient to carry the load. Perhaps concrete walls built of reinforced precast units such as slabs three or more inches thick and any convenient square dimension to permit easy handling in place are next best to the monolithic wall. The particular advantage of the precast slab wall is the ease of assembling units and the absence of forms required on the job, except those needed for casting the posts. Such a wall has



Detailed design for concrete terrace wall with coping, also lamp post, and showing alternate methods of forming panels on the surface.

a panel and pilaster effect, the posts being the pilasters and the slabs the panels. The same applies to walls which may be built of cement silo staves although these cannot be considered so attractive as the other type because of the greater number of pilasters and panels and the smaller units, so the use of concrete silo staves for such walls has been confined largely to enclosure of the barnyard or feed lot.

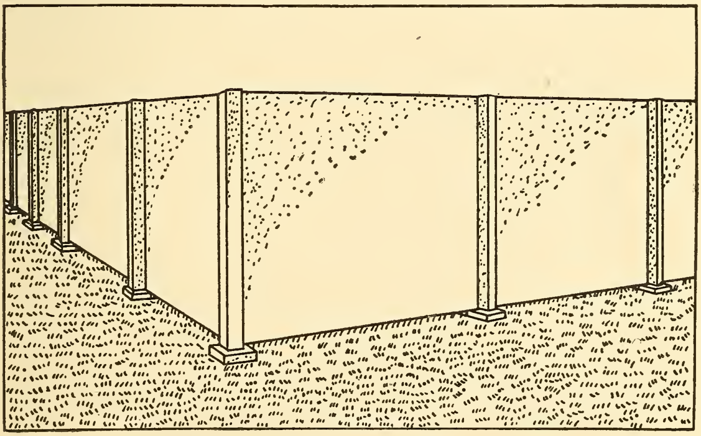


Sketch showing method of laying out concrete foundations in order to square corners. Part of the trench is illustrated as excavated in order to visualize better the operation.

Variety of Forms That May Be Used. There are two general types of forms used in the construction of monolithic walls. Wood forms built for a large section or the entire wall before concreting is begun and portable wood or metal forms erected in place for a particular stretch of the work and changed by being passed ahead and set up as the work progresses. Forms of the first type are usually built where they are used and if they are carefully planned before lumber is cut, there need be but little waste of the material. The same applies to sec-

tional forms also. Sectional or unit forms of wood can be used a number of times, and added life can be insured them by facing the side to lie next to the concrete with metal. This not only protects the sections against early injury from setting up and knocking down but results in securing a more even surface to the finished concrete.

As enclosure walls are usually built as a finishing touch to some ground or location, it is always desirable that the concrete present an attractive appearance after the job is finished. For this reason all effort expended to insure correct forms is well repaid in the added attractiveness of the finished work. For some work, tongued or grooved lumber will give best results. Units



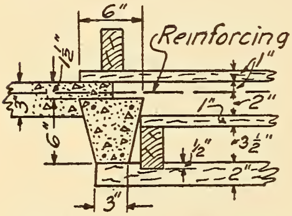
Perspective sketch of finished concrete fence.

or panel sections must be well braced to prevent bulging when concrete is rammed in place. One and one quarter inch sheathing with studs every two feet and sufficient bracing will probably be satisfactory. Long as well as short braces should be used and the longer the pieces the more of them there should be because of the tendency of long sticks to bend or sag.

The average barnyard wall is rarely more than six feet high and concrete is usually placed between forms by dumping from hand buckets or wheelbarrows run up runways. Where concrete is being mixed by hand, the mixing board should be moved with sufficient frequency so that unnecessary carrying of concrete will be avoided.

Wall Finish. The plain concrete wall surface is monotonous and there is considerable opportunity for relieving this monotony when building this wall, especially some enclosure or retaining wall, by planning the forms so that depressed or raised panels will be formed on the exposed surface.

Expansion Joints. The principal reason for reinforcing concrete walls is to prevent cracking from possible settling and from temperature changes rather than because of any need of supporting loads. As a matter of fact, the concrete wall which serves merely as an enclosure wall has no load to support other than its own weight. Expansion and contraction are provided for by joints in the work; in other words, every 25 or 30 feet one section ends and another begins. The two usually abut each other by one end of the wall having a tongue or tenon on it and the other a mortise. To give a pilaster and panel effect, however, the mortise is generally formed in the post that corresponds to the pilaster and the panel by being cast into the mortise acts as the tongue. In this way openings or joints due to contraction are not noticeable. It is possible however, to do away entirely with expansion or contraction joints by uniform and continuous reinforcement throughout the wall. In such case the steel takes all the tension when concrete is expanding.

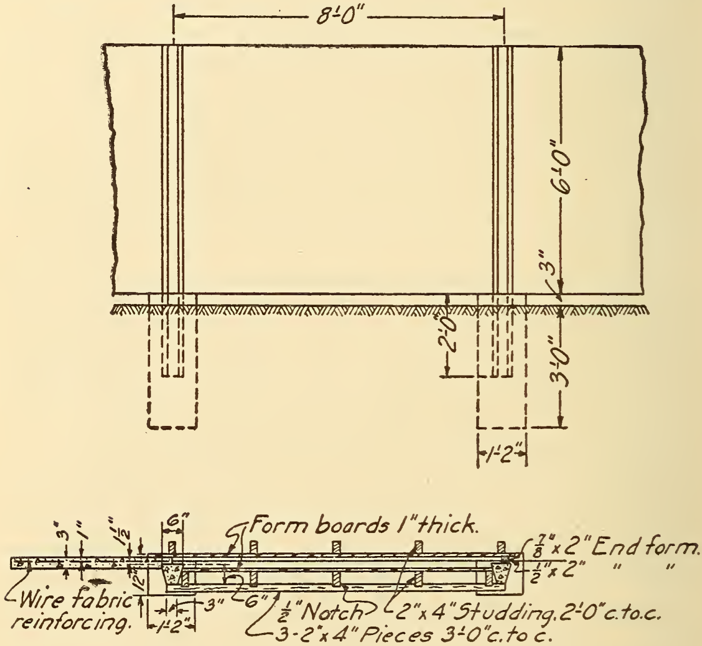


Details of posts and panels showing various dimensions and the position of reinforcing.

Casting Posts in Place. The average monolithic wall is more or less of a unit built structure. As mentioned previously, monolithic posts are generally cast first with a mortise in two opposite faces. When the concrete in these posts has been hardened so that forms may be removed, the unit sections for the wall proper are set up and the stretches between posts concreted after reinforcement has been placed in position. In such a case the posts are of more massive section than the wall, partly for economy of concrete in the intervening sections or slabs. As in the case of other concrete work, plans may be made when doing the concreting or after it is finished to give the wall any one of a number of surface finishes.

Typical examples of concrete enclosure walls are shown in accompanying sketches and photographic illustrations. One illustration suggests a simple method of form construction adaptable to all types of plain surfaced concrete wall, that is, a wall which is not to be ornamented by raised or depressed panels. It will be noticed from these sketches also that wall thickness can be varied almost at will without any particular change in the forms, this being regulated entirely by the dimensions of the block forming the posts, when cast. These posts may be cast monolithic in place or as is most common, be made of precast hollow block laid up and then filled with concrete. In either case reinforcement should be set in the corners of the square indicated as an opening in the section. If hollow block are used in building up these columns, the core should be filled with a rather wet concrete thoroughly settled in the cores so that it will perfectly unite with the four reinforcing rods. A little examination of this sketch will show how readily sections of the posts may be modified by simply planning the forms differently so that different wall thicknesses

may readily be secured and also the pilaster effect be obtained by merely clamping the form sections against different faces or projections on the posts or columns. This type of form construction has almost unlimited adaptability in building all classes of walls. In fact, one to three courses or tiers of plank may be used in accordance with



Section and elevation of concrete panel fence.

the number of workmen on the job and the speed with which they can do concreting. Also the system is particularly adapted to the construction of residences or building walls as will be seen in the sketch suggesting a corner of a building.

Plastered or Stucco Walls. Sometimes walls are built after the same manner as stucco work is done.

However, such walls cannot be expected to give very satisfactory service unless the foundation frame on which the stucco is applied is of metal throughout. The posts to which metal lath are to be attached should be embedded in the concrete foundation and set perfectly plumb and the metal lath firmly stretched between them. The plaster is then applied in the same manner as described elsewhere in this blooklet in the discussion of stucco. A very pleasing and desirable finish can be given to concrete walls by precast caps set on columns and stringers placed on walls, or when planning the forms arrangements can be made to cast these finishing details monolithic with the remainder of the wall.

BEARING POWER OF SOILS

	Supporting Power In Tons per Sq. Ft.
Rock—in thick layers, in natural bed	200
Clay—in thick beds, always dry	4
Clay—in thick beds, moderately dry	2
Clay—soft	1
Gravel and coarse sand, well cemented	8
Sand—compact and well cemented	4
Sand—clean and dry	2
Loam soils	0.5

CONCRETE FOUNDATIONS, WALLS, ETC.

1 Cu. Ft. Concrete	Sacks of Cement	1 Cu. Yd. Concrete	Bbl. of Cement
1:1:1	.5404	1:1:1	3.375
1:1½:3	.2808	1:1⅛:3	1.895
1:2:4	.2220	1:2:4	1.498
1:2½:5	.1848	1:2½:5	1.247
1:3:6	.1570	1:3:6	1.060

MATERIALS REQUIRED FOR 100 SQ. FT. OF SURFACE FOR VARYING THICKNESS OF COURSE

Thickness	1 in.			2 in.			4 in.			5 in.		
Mix	C.	Sd.	St.	C.	Sd.	St,	C.	Sd.	St.	C.	Sd.	St.
1:2	3.9	0.29	....	7.9	0.58	....	....	....	....	....	....	....
1:1:1	4.2	0.15	0.15	8.3	0.31	0.31	....	....	....	....	....	....
1:1:1½	3.7	0.14	0.20	7.3	0.27	0.41	....	....	....	....	....	....
1:1½:2½	2.6	0.14	0.24	5.1	0.28	0.47	....	....	....	....	....	....
1:1½:3	....	....	....	....	....	....	9.4	0.52	1.04	11.7	0.65	1.30
1:2:3	....	....	....	....	....	....	8.6	0.64	0.95	10.8	0.80	1.19
1:2:4	....	....	....	....	....	....	7.4	0.55	1.10	9.3	0.69	1.37
1:2½:4	....	....	....	....	....	....	6.9	0.64	1.02	8.6	0.80	1.27
1:2½:5	....	....	....	....	....	....	6.2	0.57	1.14	7.7	0.72	1.43
1:3:6	....	....	....	....	....	....	5.2	0.58	1.16	6.5	0.73	1.45

Thickness	6 in.			7 in.			8 in.			9 in.		
Mix	C.	Sd.	St.	C.	Sd.	St,	C.	Sd.	St.	C.	Sd.	St.
1:1½:3	14.0	0.78	1.56	16.4	0.91	1.82	18.7	1.04	2.08	21.1	1.17	2.34
1:2:3	12.9	0.95	1.43	15.0	1.11	1.67	17.2	1.27	1.90	19.3	1.43	2.14
1:2:4	11.1	0.82	1.64	12.9	0.96	1.92	14.8	1.10	2.19	16.7	1.23	2.47
1:2½:4	10.3	0.95	1.53	12.0	1.11	1.78	13.8	1.27	2.03	15.5	1.43	2.29
1:2½:5	9.2	0.86	1.72	10.8	1.00	2.00	12.3	1.14	2.29	13.9	1.29	2.57
1:3:6	7.9	0.87	1.74	9.2	1.02	2.03	10.5	1.16	2.32	11.8	1.31	2.61

NOTE—Quantities expressed in the following units: Cement, ...sacks; sand,.... cubic yards; pebbles or broken stone,.... cubic yards.

CONVENIENT ESTIMATING TABLES AND EXAMPLES OF USE.

For convenience, concrete is usually mixed in batches, each requiring one sack of cement. The following table shows the cubic feet of sand and pebbles (or crushed stone) to be mixed with one sack of cement to secure mixtures of the different proportions indicated in the first column. The last column gives the resulting volume in cubic feet of compacted mortar or concrete.

TABLE I

Mixtures.			Materials.			Vol. in Cu. Ft.	
Cement	Sand	Pebbles or Stone	Cement in Sacks	Sand Cu. Ft.	Pebbles or Stone Cu. Ft.	Mortar	Concrete
1	1.5		1	1.5		1.75	
1	2		1	2		2.1	
1	3		1	3		2.8	
1	1.5	3	1	1.5	3		3.5
1	2	3	1	2	3		3.9
1	2	4	1	2	4		4.5
1	2.5	4	1	2.5	4		4.8
1	2.5	5	1	2.5	5		5.4
1	3	5	1	3	5		5.8

The following table gives the number of sacks of cement and cubic feet of sand and pebbles (or stone) required to make one cubic yard (twenty-seven cubic feet) of compacted concrete proportioned as indicated in first column:

TABLE II

Mixtures			Quantities of Materials		
Cement	Sand	Pebbles or Stone	Cement in Sacks	Sand Cu. Ft.	Stone or Pebbles Cu. Ft.
1	1.5				
1	2		15.5	23.2	
1	3		12.8	25.6	
1	1.5	3	9.6	28.8	
1	2	3	7.6	11.4	22.8
1	2	4	7	14	21
1	2.5	4	6	12	24
1	2.5	5	5.6	14	22.4
1	3	5	5	12.5	25
1	3	6	4.6	13.8	23
			4.2	12.6	25.2

Example I. How much cement, sand, and pebbles will be required to build a feeding floor 30 by 24 feet, 5 inches thick?

Multiplying the area (30 by 24) by the thickness in feet gives 300 cubic feet, and dividing this by 27 gives 11 1/9 cubic yards as the required volume of concrete. A one-course floor should be of 1:2:3 mixture. Table II shows that each cubic yard of this mixture required 7 sacks of cement, 14 cubic feet of sand, and 21 cubic feet of gravel or stone. Multiplying these quantities by the number of cubic yards required (11 1/9) gives the quantities of material required (eliminating fractions) as 78 sacks of cement, 156 cubic feet of sand, and 233 cubic feet of pebbles or stone. As there are 4 sacks of cement in a barrel, and 27 cubic feet of sand or pebbles in a cubic yard, we shall need a little less than 20 barrels of cement, 6 cubic yards of sand, and 9 cubic yards of pebbles or stone.

Example II. How many fence posts 3 by 3 inches at the top, 5 by 5 inches at the bottom, and 7 feet long can be made from one sack of cement? How much sand and pebbles will be needed?

Fence posts should be of a 1:2:3 mixture. Table I shows the volume of a one-sack batch of this mixture to be 3 9/10 cubic feet. The volume of one concrete post, found by multiplying the length by the average width and breadth in feet (7 by ⅓ by ⅓) is 7/9 cubic foot. By dividing 3 9/10 by 7/9 we find that five posts can be made from 1 sack of cement when mixed with 2 cubic feet of sand and 3 cubic feet of pebbles.

Example III. What quantities of cement, sand and pebbles are necessary to make 100 unfaced concrete blocks, each 8 by 8 by 16 inches?

The product of height, width and thickness, all in feet (2/3 by 2/3 by 4/3) gives 16/27 cubic foot as the contents of a solid block. As the air space is usually estimated as 33 1/3 per cent, the volume of concrete in one hollow block will be 2/3 or 18/27 or 54/81 cubic foot; in 100 blocks the volume of concrete will be 5400/81 or 66 2/3 cubic feet, which being divided by 27, gives a little less than 2½ cubic yards. Unfaced concrete block should be of 1:2½:4 mixture. Table II shows that each cubic yard of this mixture requires 5 6/10 sacks of cement, 14 cubic feet of sand, and 22 4/10 cubic feet of pebbles. Multiplying these quantities by the number of cubic yards required (1½) gives the quantities of material required as 8 2/5 sacks of cement, 21 cubic feet of sand, and 33 3/5 cubic feet of gravel.

Example IV. How many 6-foot hog troughs 12 inches wide and 10 inches high can be made from 1 barrel of cement?

Use a 1:2:3 mixture. Table I shows the volume of a 1-sack batch of this mixture to be 3 9/10 cubic feet. As there are 4 sacks in 1 barrel, a barrel of cement would be sufficient for four times 3 9/10, or 15 6/10 cubic feet of concrete. The product of the three dimensions, all in feet, gives the volume of one trough as 5 cubic feet.

However, approximately 30 per cent of this volume **is in** the open water basin or inside of the tank, leaving 3 5/10 cubic feet as the solid contents of concrete in one trough. Dividing 15 6/10 by 3 5/10, we find that 4 troughs (and a fraction over) can be made from 1 barrel of cement when mixed with 8 cubic feet of sand and 12 cubic feet of pebbles.

QUANTITIES OF PORTLAND CEMENT, SAND AND PEBBLES OR CRUSHED STONE FOR 100 SQUARE FEET OF CONCRETE 10 INCHES THICK, EQUAL TO 3.08 CUBIC YARDS

Proportions			Quantities		
Sacks of Cement	Cu. Ft. of Sand	Cu. Ft. Pebbles or Stone	Sacks of Cement	Cu. Yd. of Sand	Cu. Yd. Pebbles or Stone
1	1	...	60.2	2.23	...
1	1½	...	47.7	2.65	...
1	2	...	39.4	2.92	...
1	2½	...	33.8	3.13	...
1	3	...	29.5	3.29	...
1	1	1	41.7	1.54	1.54
1	1½	3	23.4	1.30	2.60
1	2	3	21.5	1.59	2.38
1	2	4	18.5	1.37	2.74
1	2½	4	17.2	1.59	2.54
1	2½	5	15.4	1.43	2.86
1	3	5	14.2	1.58	2.64

NOTE—These quantities can be safely used for estimating, ordering materials, and, after the work is done, as a check to prove that the required quantity of cement has been used. Actual quantity of materials used in the concrete should not vary more than ten per cent above or below the quantities given in the table.

This table can readily be used for any concrete structures which can be measured in area and which are of uniform thickness over any considerable area, such as walls, floors, and walks.

The following examples illustrate the use of the table:

Example 1. Required the quantity of materials for a 12-inch thick basement wall, 6 feet 5 inches high above footing, for a house 25 feet by 40 feet outside dimensions.

The footing 1 foot 6 inches and 6 inches thick. Concrete proportioned 1:3:5.

Wall:
Length of wall 25+25+39+39=128 ft.
Height of wall 6 ft. 5 in.=6 5/12=6.417 ft.
Area of wall=128×6.417=821.4 sq. ft.
Thickness of wall=12 in.
Quantities of materials for wall concrete:
Factor for multiplying units in table=
$\frac{821.4}{100} \times \frac{12}{10} = 8.214 \times 1.2 = 9.8568$; Take 9.86
Sacks of cement=14.2×9.86=140.0
Cu. yd. of sand=1.58×9.86=15.6
Cu. yd. of pebbles or crushed stone=2.64×9.86=25.0
Footing:
Length of footing=25.5+25.5+37.5+37.5=126 ft.
Width of footing=1 ft. 6 in.=1 6/12=1.5 ft.
Area of footing=126×1.5=189 ft.
Thickness of footing=6 in.
Quantities of materials for footing:
Factor for multiplying units in the table=
$\frac{189}{100} \times \frac{6}{10} = 189 \times .6 = 1.134 = 1.13$
Sacks of cement=14.2×1.13=16.0
Cu. yd. of sand=1.58×1.13=1.8
Cu. yd. of pebbles or stone=2.64×1.13=3.0
Total quantities of materials:
Sacks of cement=140+16=156.0
Cu. yd. of sand=15.6+1.8=17.4 or 17.5
Cu. yd. of pebbles=26.0+3=29.0

Example 2. Required the quantities for a concrete floor for a basement. Interior dimensions of the basement 23 feet by 38 feet. Floor 5 inches thick over all, with 4-inch base of concrete proportioned 1:2½:5, and 1-inch wearing course composed of cement mortar proportioned 1:2.

Area of floor=23×38=874 sq. ft.
Factor for multiplying quantities in table for base=
$\frac{874}{100} \times \frac{4}{10} = 8.74 \times .4 = 3.5$
Quantities of materials for base concrete:
Sacks of cement=15.4×3.5=54.0
Cu. yd. of sand=1.43×3.5=5.0
Cu. yd. of pebbles or stone=2.86×3.5=10.0
Factor for multiplying quantities in table for wearing surface=
$\frac{874}{100} \times \frac{1}{10} = 8.74 \times .1 = .9$
Quantities of materials for wearing surface mortar:
Sacks of cement=39.4×.9=35.5
Cu. yd. sand=2.92×.9=2.6 cu. yd.
Total quantities of materials for floor:
Sacks of cement=54.0+35.4=89.5
Cu. yd. of sand=5.0+2.6=7.6 or 7.5
Cu. yd. of pebbles or stone=10.0

SURFACE AREA (IN SQUARE FEET) OF CONCRETE SLABS OR WALLS OF VARIOUS THICKNESSES AND PROPORTIONS THAT CAN BE MADE WITH ONE SACK OF CEMENT

Thickness of Slab or Wall in Inches	Concrete Mixture				
	1:2:3	1:2:4	1:2½:4	1:2½:5	1:3:5
3	15.52	17.88	19.42	21.77	23.2
3⅛	13.31	15.33	16.65	18.67	19.9
4	11.64	13.41	14.56	16.33	17.4
4½	10.36	11.93	12.96	14.53	15.5
5	9.31	10.73	11.65	13.06	13.9
5½	8.46	9.74	10.58	11.86	12.6
6	7.76	8.94	9.71	10.88	11.6
6½	7.18	8.27	8.98	10.07	10.7
7	6.65	7.66	8.33	9.33	9.9
8	5.82	6.70	7.28	8.16	8.7
10	4.66	5.36	5.83	6.53	6.9
11	3.88	4.47	4.85	5.44	5.8
12	3.32	3.83	4.16	4.66	4.7
14	2.91	3.35	3.64	4.08	4.3
16					

TANKS, TROUGHS, CISTERNS, AND SIMILAR CONTAINERS FOR LIQUIDS

Requirements. The most important requirement of a structure that is to hold any kind of liquid is that it be watertight. It is very important, therefore, that in using concrete for troughs, tanks, cisterns and similar structures, some greater care perhaps be taken in selecting, proportioning, mixing and placing the concrete than

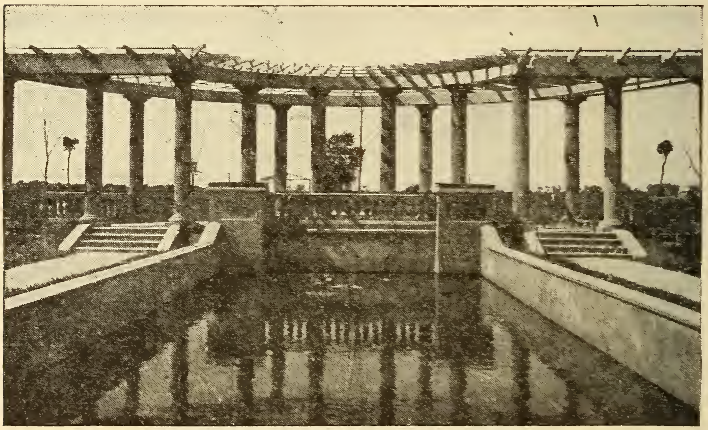
Concrete milk cooling tank.

would be absolutely necessary in connection with some other classes of concrete work.

Hog wallows, dipping vats and manure pits properly fall into the classification of tanks because the prime essential of these structures is that they hold liquid. For that reason they are grouped under this one heading for

convenience in describing the fundamental principles of concrete construction as applied to structures which first of all must be watertight.

Shapes of Tanks. Tanks may be either rectangular or circular, but because form construction is easier, usually a square or rectangular structure is adopted in preference to the circular one. However, if one desires to build a circular stock tank for example, the principles of form construction applying are well illustrated by the home



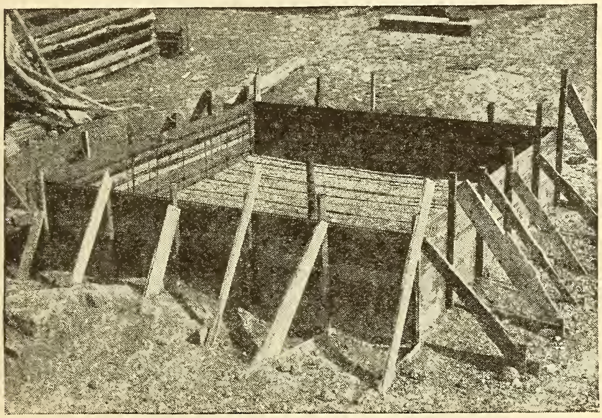
Concrete swimming pool and pergola suggesting an attractive and enjoyable addition to the home grounds.

made silo forms described elsewhere, which need little modification to make them fit the requirements of circular tank construction.

Continuous Concreting Desirable. In planning to build a trough or tank every effort should be made to arrange to carry on the concreting continuously. This is the surest way to prevent leakage, if concreting is otherwise after good practice. For tanks that are to hold water a 1:2:3 concrete is recommended. For manure pits

and hog wallows a 1:2:4 or possibly 1:2½:5 mixture will serve if the materials are thoroughly graded and carefully proportioned.

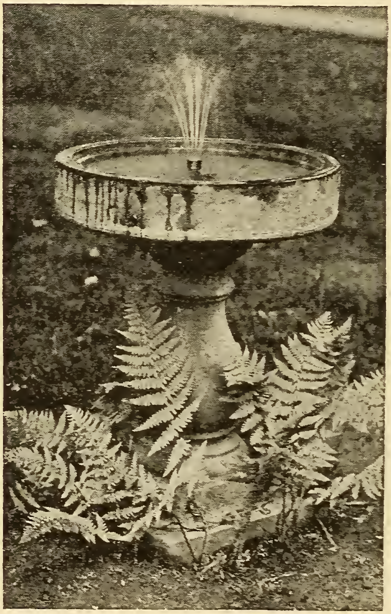
Reinforcement. Because of the pressure exerted by contained contents, tanks and troughs must be reinforced. Each structure of this kind is, therefore, a problem of itself, but for the purpose of example we will take a watering trough such as might be used in the barnyard, 30 inches wide, 18 inches deep and 6 feet long, in-



Outside forms set up for concrete watering trough. Reinforcement is also shown in position.

side dimensions. There are a number of ways of going about the building of such a tank, but perhaps the one illustrated in an accompanying drawing is about as good as any to follow. First, outside forms are set up. Then concrete is placed to half the thickness of the floor slab and reinforcement set in position. Then the remainder of the concrete placed to the floor. Then the inside form is set and concreting continued for the section corresponding to the side walls and ends of the tank. For a tank of this size either ¼-inch round rods or triangle mesh fabric such as described in the section under

reinforcement may be used. If rods are used they should be continuous from top of side down through bottom and up opposite side and the same in ends so that the reinforcement forms what amounts to a cage or basket. The rods should be tied together where they cross with soft iron wire so as to hold them in correct position while

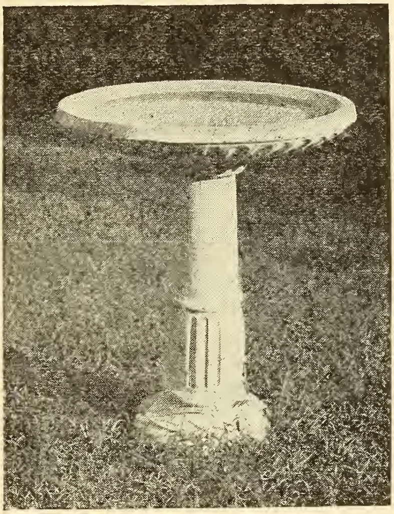


Concrete fountain or bird fount.

placing the concrete, and care should be taken not to dislodge reinforcement while spading the concrete in the forms.

Consistency of Concrete. No other class of concrete construction requires greater care in mixing and placing concrete. Consistency must be exactly right—a quaky mixture. Spading must be thorough against both form faces to produce a dense, watertight surface. Forms

should not be removed until a day or two after the last concrete has been placed, and until removed the entire work should be covered up with hay or straw to keep the concrete from drying out. When forms are removed any irregularities in the surface due to neglect to thoroughly spade the concrete should be patched up with a cement mortar and if desired to give a more even finish, the surface may be rubbed down inside and out with

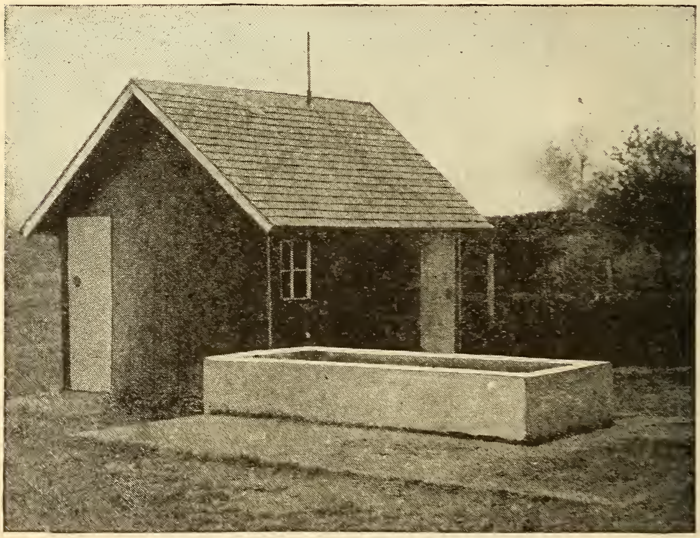


Ornamental concrete bird bath.

a wood float or with a carborundum brick as described under rubbed surface finishes.

Batter of Inside Wall Face. It will be noticed in the sketch that in the inner wall faces slope or have a batter. The purpose of this is to relieve pressure of ice due to freezing of water, as the battered sides tend to cause the ice as it forms to rise and as thickness increases, it will bow up in the center and take most of the press away from walls,

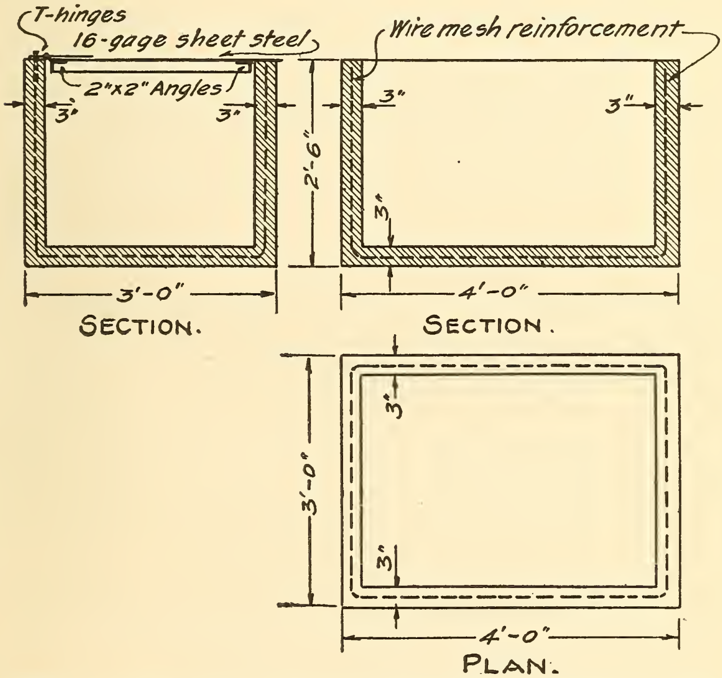
Importance of All Details. Probably no other class of concrete construction has been responsible for so much complaint concerning the merits of concrete as have concrete tanks. Lots of leaky tanks have been built, lots of tanks have gone to pieces after building and therefore the builders were convinced that concrete was not a good building material. Invariably the cause of



Rectangular concrete watering trough with concrete pavement around it. Such a pavement is desirable to keep the surroundings from becoming a mudhole.

these troubles can be traced to disregard of some seemingly trivial yet very important fundamental that was not observed. Old iron or other scrap material has been used for reinforcement instead of rods or mesh especially intended for the purpose. Care has not been taken, perhaps, to properly lap reinforcement where it was necessary to splice it. Laps have perhaps been allowed to fall near a corner instead of at the center of an end or side

thus making the hoops or bands of reinforcement practically continuous around the structure. Again, forms have been removed and the concrete allowed to dry out rapidly without any means taken to protect it from sun and wind. As mentioned a number of times, concrete

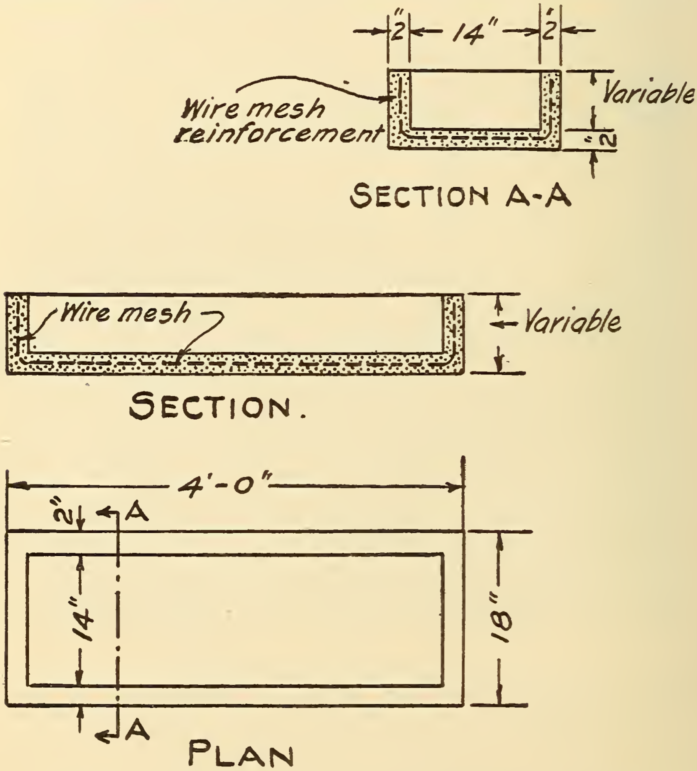


Details of simple small concrete watering trough or feed box with mesh reinforcement. The upper left hand sketch illustrates steel cover which will be used in case this is employed as a feed box.

will not acquire proper strength or density unless during the first week or so after placed it is kept thoroughly wet down so that the necessary chemical action in the cement can take place.

Stopping Concrete Work to Resume Later. If by any chance concreting on a tank of this kind cannot be continued from start to finish, then a special provision

not so far described should be taken when the work is stopped to prevent leakage through a construction seam. This is usually done by embedding a strip of tin say six inches wide for three inches of its width all around in the concrete placed in the forms along a line corresponding



Design for small concrete tray intended for poultry feeding.

to the center of the wall section, and leaving the concrete each side of it roughened to provide better bond for the next concrete when work is resumed. Before resuming work the concrete surface in the form should be washed clean and painted with cement paint and the

three inches of tin strip exposed should be painted in the same manner and fresh concrete placed before this cement paint has had a chance to commence hardening.

Inlet and Outlet Fixtures. In planning forms and setting them up for building a tank like described, it is necessary to arrange for inlet and outlet pipes so that the tank can be kept filled and easily drained when necessary to clean it out at intervals. The outlet should be so arranged that its top will be level with the top of the floor in the tank and should be threaded on the inside to permit screwing a piece of pipe into it that will stand up to a height corresponding to the desired water level. In such a case the pipe serves also as an overflow outlet.

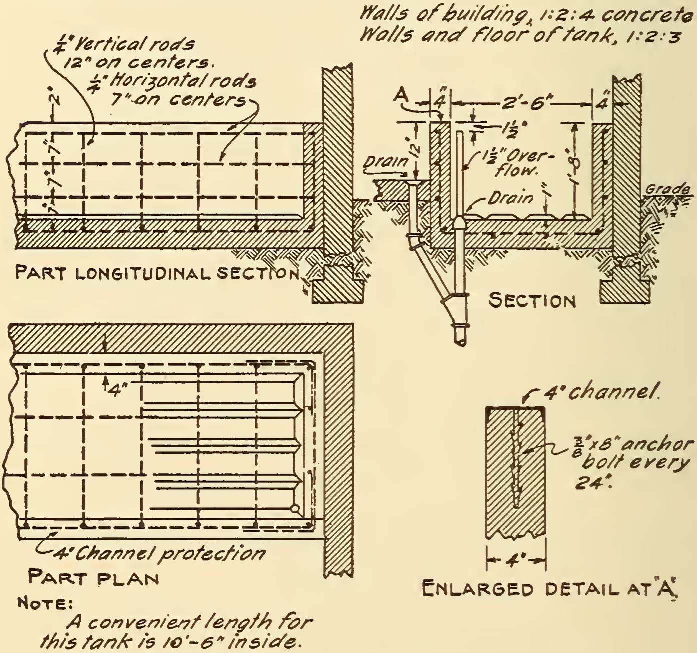
Pavement Around Tank. A concrete watering trough, especially in the pasture lot and barnyard should have a paved area around it for cattle to stand on while drinking so that the ground in the vicinity of the tank will not become a mudhole. How a pavement of this kind should be built is described in another section where floors, walks and similar pavements are discussed.

REPAIRING LEAKS IN CONCRETE TANKS AND CISTERNS

Leaky concrete troughs, tanks or cisterns result from one or more of several conditions. The concrete mixture may not have been properly proportioned so as to reduce voids to a minimum; too little water may have been used, thus making it impossible to puddle the concrete in the forms to maximum density; too little reinforcing may have been used, resulting in cracks due to settlement, earth pressure, or expansion under temperature changes, or the concreting may not have been carried on con-

tinuously, thus producing construction joints or seams through which leakage could take place. Although prevention is better than cure, nevertheless some of these faults of construction can, in a measure, be remedied by various treatments.

When leakage from a cistern or a tank consists merely of slight seepage of contents through the walls, a coat-



Various details of concrete milk cooling tank.

ing of cement plaster may be applied to the interior of the tank as a preventive. Preparatory to applying this coating, the surface to be treated should be thoroughly cleansed by scrubbing with a good stiff brush, and water, or better still, wash the surface with a solution of 1 part hydrochloric acid to 3 or 4 parts water, allowing this to remain for a few moments and then thoroughly rinsing

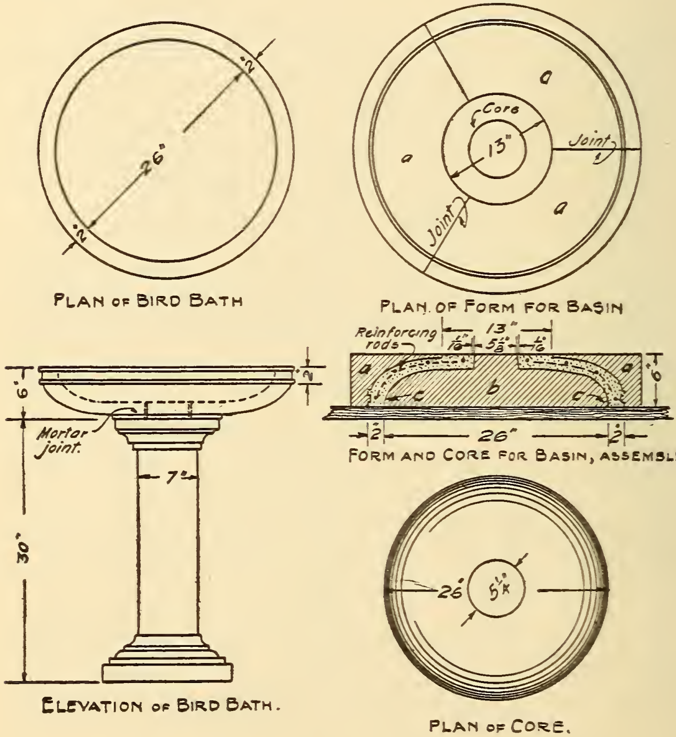
off the concrete surface with clean water. The acid treatment will remove the cement coating from the particles of sand, thus exposing clean surfaces, to which the cement plaster will more readily bond or adhere.

Immediately before applying the cement plaster, the cleansed surface should be painted with a grout of neat cement mortar mixed to the consistency of cream. This grout can be applied with an ordinary brush, but should not be used very far in advance of the plastering, so that the grout paint will not have had opportunity to commence hardening before the plaster is applied.

Plastering mortar for this purpose should be mixed in the proportion 1:1½. No more mortar should be mixed than can be used within 30 minutes. It can be applied with a steel trowel and the surface should subsequently be worked thoroughly as soon as possible with a wood float to make a dense, impervious coating. Final finishing may be done with a steel trowel. After having finished the plastering, the surface must be protected from too rapid drying out, by being kept wet for several days to insure uniform curing or hardening of the mortar, and hence preventing cracks.

Another method sometimes used to repair leaky tank walls consists in applying to the inside of the structure a solution of what is known as sodium silicate, commercially called "water glass." This chemical is dissolved in water in the proportion of 1 part silicate to 3 or 4 parts of water, depending upon the porosity of the wall surface. Two of three coats of this solution applied at intervals of 24 hours may be necessary to fill up the pores in the concrete. Effectiveness of the sodium silicate application depends upon a chemical combination between the silicate and alkalis present in the concrete, resulting in the formation of insoluble compounds.

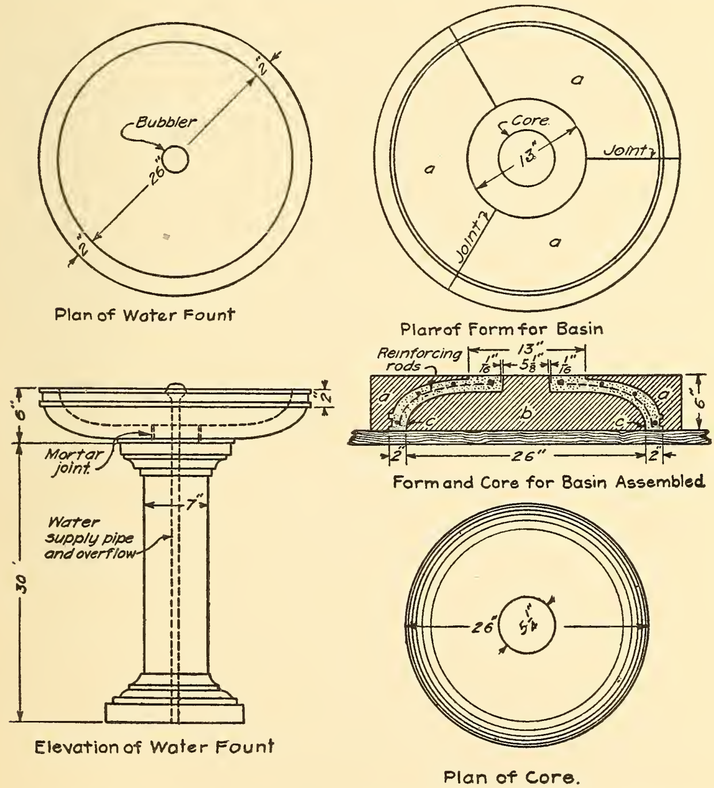
Cracks in tank, trough or cistern walls may sometimes be repaired by cutting out on each side of the crack so as to form a V-shaped groove, say 1½ inches deep and about an inch wide at the surface. After hav-



Details of concrete pedestal and bird bath basin showing form and core for basin assembled. Some woodwork on a lathe is necessary to make a form of this kind.

ing been thoroughly cleansed out, this groove may be calked with oakum soaked in tar, so that about one-half of its depth is filled. The remainder of the groove should be filled with cement mortar mixed 1 :2. Or, after having calked the bottom of the crack with oakum, a plastic mix-

ture consisting of pine tar and portland cement combined in proportions so as to make a paste as stiff as can be conveniently handled, can be worked into the groove. This preparation may harden slightly while being used, but



Modification of the concrete bird bath adapting it to a bubbling fountain. With this exception form construction is exactly the same as in the former case.

can be kept plastic by subjecting it to moderate heat in the metal receptacle in which mixed.

Where cracks are due to insufficient reinforcing or to lack of reinforcing, the repair methods suggested will

be of little or no avail. About all that can be done in such case is to build a new structure or at best, to use the old one as an inner or outer form and deposit a new shell of concrete inside or outside of the old structure. This may be from two to four or more inches thick, depending upon conditions, and to prevent a recurrence of the cracking, should be properly reinforced. 1:2:3 mixture of properly graded materials mixed with the right amount of water and properly placed, is insurance against leaky construction.

CONCRETE FLOORS, WALKS AND SIMILAR CONCRETE PAVEMENTS

General. Concrete floors, walks and some other types of concrete pavements may well be grouped for description under one head since they have in common the same features. Minor variations apply only to certain details of construction as relates to the particular use to which the floor or pavement is to be put and these differences will be pointed out in the description of the various classes of floors or pavements.

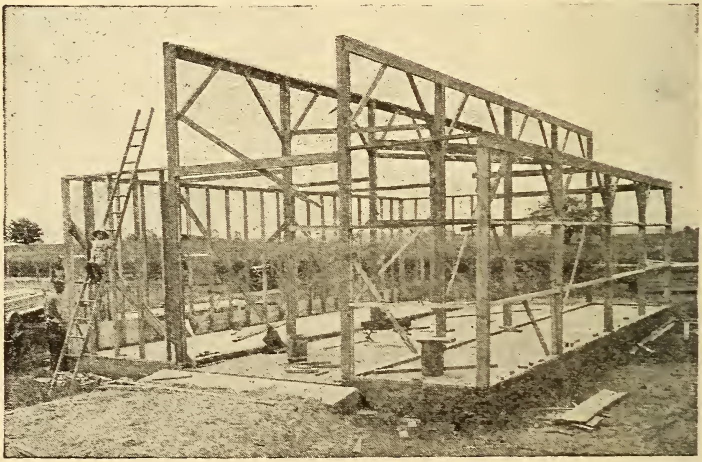
On the farm concrete floors are used in the horse barn, cow barn, corn crib, hog house, poultry house, dairy building, ice house, farm residence—everywhere in fact a floor may be needed, and such concrete floors as barnyard pavements and hog feeding floors are not unlike any other kind of concrete floor. A still further extension of the concrete floor is the driveway.

Types of Construction. Concrete floors, walks and other pavements are of two classes, depending upon the manner after which they are built, that is, they are either one course or two course construction. In one course construction a relatively rich concrete such as a 1:2:3 mixture is used throughout and placed in one operation, while in two course construction a leaner concrete, that is, one containing less cement, such as a 1:2½:5 mixture is used for the base and a richer sand cement mortar such as a 1:2 or 1:2½ or some similar mixture is used for a top or wearing course.

When Reinforced. Concrete floors that are supported only around their edges, that is, like a floor in a barn hayloft, must be reinforced. Sometimes other classes of

concrete floors are reinforced, but in general because of their location and use reinforcement of floors and pavements laid on the ground is dispensed with by making them thicker.

Hog Feeding Floor. Perhaps the most profitable floor that a farmer can build is a concrete feeding floor in the hog lot. There is not only a greater gain in weight of hogs fed on such a floor because of the cleanliness of the surface and hence freedom from risk of stock diseases, but



Concrete floor in place for concrete corn crib.

there is the economy resulting from the fact that less feed is required to produce a given gain in weight of stock because none of the feed can be trampled in the mud.

Concrete feeding floors can be cleaned readily by scrubbing, and if need be, may be disinfected by adding some germicidal solution to the washing water. Every rain helps to clean the surface and sunshine exerts its beneficial influences in destroying and preventing disease germs.

Concrete feeding floors may be likened to a series of concrete sidewalks placed side by side. The average concrete walk is a stretch of concrete, say 4 or more feet wide, divided into slabs 4, 5 or 6 feet long, and if the walk were taken up in stretches and these laid side by side there would be formed a sort of a checker board of concrete slabs which would represent the concrete feeding floor.

To meet all desirable requirements a feeding floor must have a surface that will be even, yet not too smooth to endanger the safety of animals when walking on it; it must be easily kept clean; not absorb waste that may be dropped upon it, and should not provide a breeding place for rats, mice or other pests. The concrete floor meets all requirements that could be named for a feeding floor.

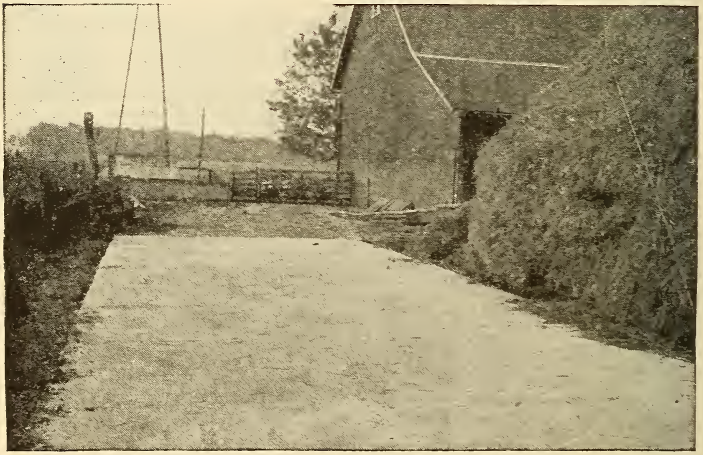
Advantage of One Course Construction. Generally speaking, for feeding floors, barnyard pavements and walks one course construction is to be preferred. In two course construction there is always a possibility that the concrete for the first course will have begun to harden before the top, or wearing course, can be placed, and if that is the case, there is likely to be difficulty later from the top cracking because not bonded to the base. For this reason the one course floor is preferable.

Forms Required and Manner of Setting. Forms required for building a concrete feeding floor or laying concrete pavement in the barnyard are simple. The two classes of construction may be covered in one description since what applies to one applies almost literally to the other. Ordinarily hog feeding floors should not be less than 4 inches thick. However, it would be better to make them 5 inches.

Barnyard pavements are likely to be subjected to the traffic of loaded wagons so they should be not less than 6 inches thick. Forms used should be of lumber, one dimension of which is equal to the proposed thickness of the

floor. For example, if a feeding floor or barnyard pavement is to be 6 inches thick, 2 by 6's staked to true line and proper grade will be suitable material to use for forms. The forms are so staked to place that the area for each slab is marked out, and when concreting is started, alternate slabs are concreted first.

Preparing the Site. Where the soil is well drained no special subbase or foundation need be provided. All that



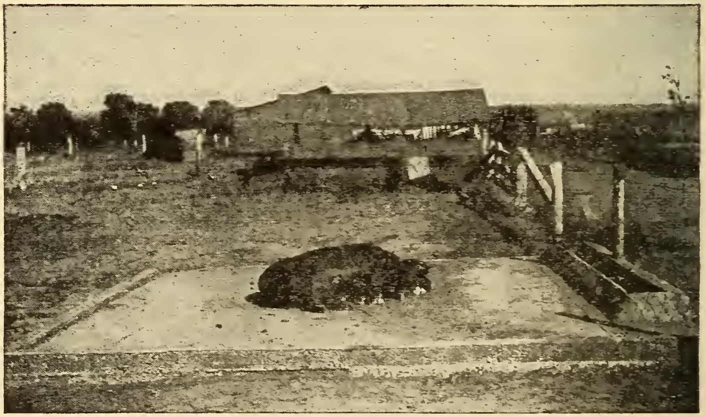
Concrete feeding floor or barnyard pavement.

is necessary is to dig off all turf, vegetable or other perishable material and fill soft spots or other places where soil is yielding, by digging out and replacing the waste material by clean gravel well compacted. The entire area should be brought to uniform grade, and consolidated so that the support for the floor will everywhere be unyielding. If the soil is not well drained it is advisable to build up the area slightly where the concrete is to be laid by placing a subbase of 6 or 8 inches of clean cinders free from ash, or a similar layer of clean gravel. When such a fill is used it should

be well compacted and should serve to raise the area where the floor is to be laid above other surroundings, because if this is not done, the area beneath the floor will become a sump or water hole that will collect and retain water. If this should freeze solid the resulting expansion will cause upheaval of the slabs. After such upheaval slabs rarely or never return to the original uniform level. When a subbase is necessary, one or two tile lines should be laid so that all possibility of water remaining beneath the pavement will be prevented.

Mixing and Placing Concrete. After having set the forms securely in place, mix 1:2:3 concrete, using enough water to make a quaky consistency. Immediately place the concrete in forms. This can be done by dumping from wheelbarrows or buckets, or with shovels. When forms have been slightly more than filled, they are struck off level with the top of forms by using a strikeboard moved backward and forward and advanced slightly each time with sawlike motion. The concrete should be of such consistency that it cannot be tamped yet will be so stiff that it will require scraping from wheelbarrow or bucket. If it is mixed to this consistency then it will be possible to finish the surface within twenty minutes or half an hour after the concrete is placed and one finishing with a wood hand float will be all that is necessary. The wood float if properly used will not only make a dense, compact surface, but leave a slightly gritty texture to the floor that will provide a secure foothold both to persons and to live stock that must walk over it. Steel troweling should be avoided because of the tendency to produce too smooth and slick a surface in this manner and also because overtroweling, which is quite likely to happen in the attempt to finish a true surface, will bring an excess of cement to the surface and so reduce the wearing quality of the floor.

Size of Slabs. Concrete feeding floors are usually laid in slabs from 6 to 10 feet square. Barnyard pavements are usually laid in slabs about 10 feet square. When concrete of the slabs first placed has hardened so forms can be removed, the hardened concrete serves as forms for placing concrete for alternate slabs. Care should be taken when setting forms for a feeding floor or barnyard pavement that the cross pieces marking the boundaries of various slabs are so set that after the first slabs have been concreted,



Another example of concrete feeding floor where a small watering or feeding trough has been cast monolithic with the floor.

lines marking slab joints will be continuous in both directions over the floor. How this should be arranged for is shown in an accompanying sketch which illustrates some of the cross pieces staggered, thus providing for the continuous slab lines as mentioned.

Protecting the Work. Just as soon as the surface of a concrete feeding floor or barnyard pavement has hardened sufficiently to withstand pressure from one's thumb, the concrete should be covered with some protective material such as a layer of moist earth, sand, sawdust or straw and

this covering be kept wet by occasional sprinkling for at least ten days so that the concrete will harden in the presence of moisture rather than dry out. As mentioned elsewhere, the large area which a floor surface exposes to the atmosphere, makes it particularly necessary that such a covering be applied if concrete is to develop satisfactory wear-resisting hardness. After such protection as described has been given for a week or ten days, the covering may be removed and the floor put to its intended use. In the case of a barnyard pavement, however, thought must be given as to whether it is likely loaded wagons are to use the pavement and these should not be allowed on it until the concrete is at least three weeks old. Barnyard pavements and feeding floors are types of floors that rarely or never are reinforced.

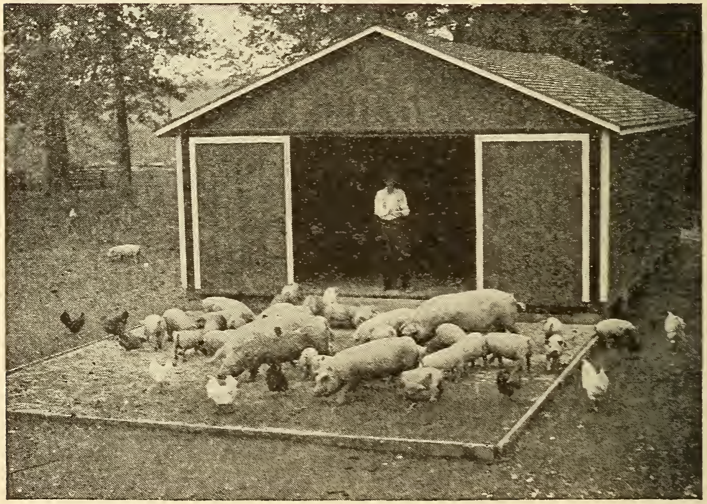
Common practice in constructing a concrete feeding floor is to provide a curb or apron at least around three sides of the floor to prevent animals from shoving grain off while feeding and also to prevent rats from burrowing beneath the floor and hogs from rooting under it. Such a curb may be 4 inches thick and 18 inches deep, 3 or 4 inches of which should extend above the level of the floor.

CONCRETE WALKS

Similar to Floors. In most essentials concrete walks are like concrete feeding floors and barnyard pavements. If one course concrete construction is used, mixing and placing is just the same as described for feeding floors and barnyard pavements. If the location where the walk is to be built is not well drained, provisions similar to those described for feeding floors should be made so that the concrete will lie on a cinder or gravel fill from which free drainage is assured by tile outlets every 20 or 30 feet. It is best, however, to dispense with fills under walks and

floors if possible to build up with the natural soil a good free drainage area upon which to lay the concrete. Unless the cinder or gravel fill is always well drained it becomes nothing but a sump for water, and defeats the very purpose for which it was intended.

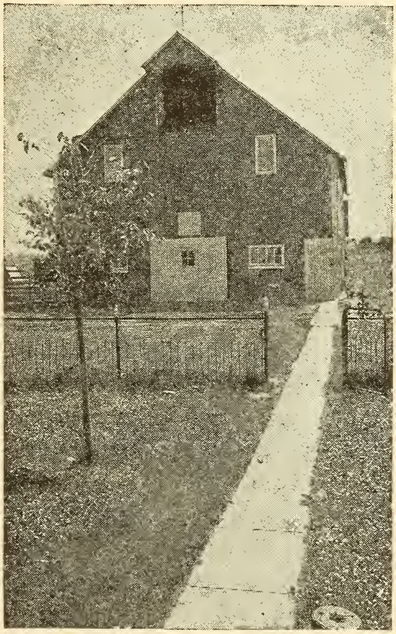
Width of Walk and Size of Slabs. Concrete walks vary in width depending upon the use to which they are to be put. In many cases a walk 30 inches wide would serve



Concrete feeding floor placed immediately at the entrance of the corn crib. Not a good location perhaps but convenient for feeding.

between and around many of the farm buildings. Certainly 3 feet would be the average width. Slabs should not have more than 36 square feet area. To secure free drainage from the surface, all pavements are either crowned slightly at the center or laid to a slight slope from one side to the other. In the case of a feeding floor or barnyard pavement, the custom is to slope the floor slightly in two directions and to place a gutter along one edge connected with a tile line leading to a manure pit so that all the fertilizing elements

washed from the floor will be carried to the pit. In the case of a concrete walk, the strikeboard used to strike off the concrete is sometimes cut out on the lower or striking face so that it will give a slight crown to the walk, making it say ¼ or ½ inch higher in the center than at either side, or the walk may be sloped slightly all to one side at the rate of not more than ½ inch to the foot.



Walks like this from the kitchen door to the barn do much to lighten farm housework.

Causes of Failures Too Commonly Seen. Nearly every one has seen concrete walks that were no recommendation of the material. The reasons for failure, however, are very evident to one who knows and appreciates good concrete practice. When the various slabs of a walk are out of level, it is certain that one of two things if not both of these

happened: Either the foundation was unstable or the soil was not well drained so that heaving resulted and was followed by unequal settlement.

Many walks may be seen where the surface is going to pieces. These are usually examples of two course construction and have failed due generally to the contractor skinning the job by putting little or no cement in the top course, or laying it of so dry a mix that what little cement there was in it could not perform its bonding or binding function; or if the concrete mixture of the base was as it should be, then scaling of the top was due to the top course not being placed until after the base had so hardened that the top could not bond to it.

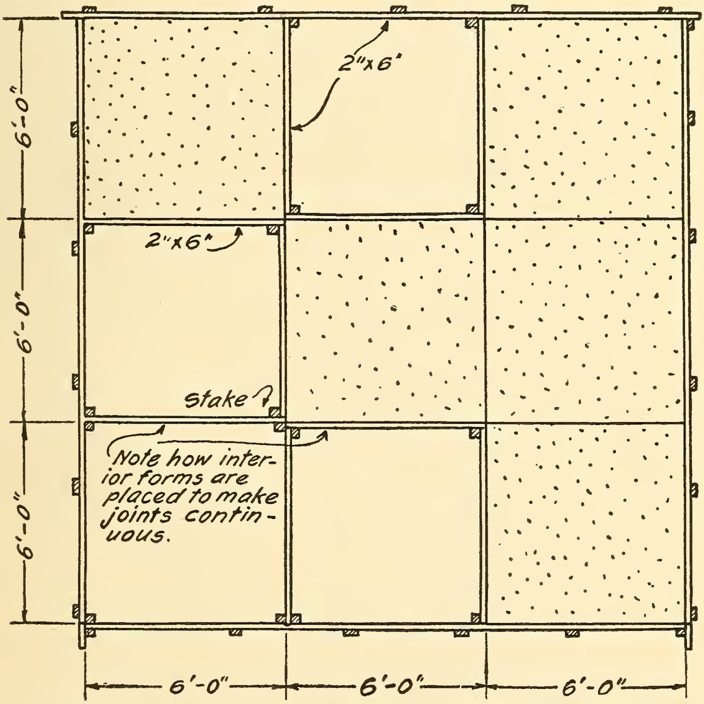
One very important detail of concrete walk construction and one which if observed would go far to prevent many poor concrete walks which we now see, is to protect the concrete after placed. One rarely sees a concrete sidewalk job that is protected from sun and wind or other drying influences by a covering, and yet this is one of the most important details of construction. As in the case of feeding floors and barnyard pavements, a concrete sidewalk should be covered for a week or ten days and the concrete kept moist so it will harden properly.

Wood float finish for a sidewalk is preferable to the smooth finish obtained by a steel trowel.

Floors Indoors. Interior floors laid on the ground, such as concrete floors in the horse barn, cow barn, milk house, corn crib, and ice house, are built after the same principles as described for walks, feeding floors and barnyard pavements, except that as the floors are indoors less consideration need be given to expansion and contraction. Because the floors are not exposed to such extremes of temperature as outdoor pavements, there is no necessity of laying the concrete in small sections or slabs like used for walks and feeding floors. In indoor floors the width of slabs or

stretches concreted is usually determined by the amount of concrete that can be placed continuously within a given time.

Barn Floors. Floors in dairy barns and horse stables generally involve construction of mangers, feed alleys, and



Plan of concrete feeding floor intended principally to illustrate manner of staking out forms so that lines marking slabs will be continuous.

manure gutters, at the same time the floor is laid. Typical sections of a dairy barn floor as built when stock are faced in and faced out are shown in accompanying sketches. Usually for this work forms are so staked into position that certain stretches of the floor like stall floor and gutter, manger and feed alley, are built as separate operations instead of at-

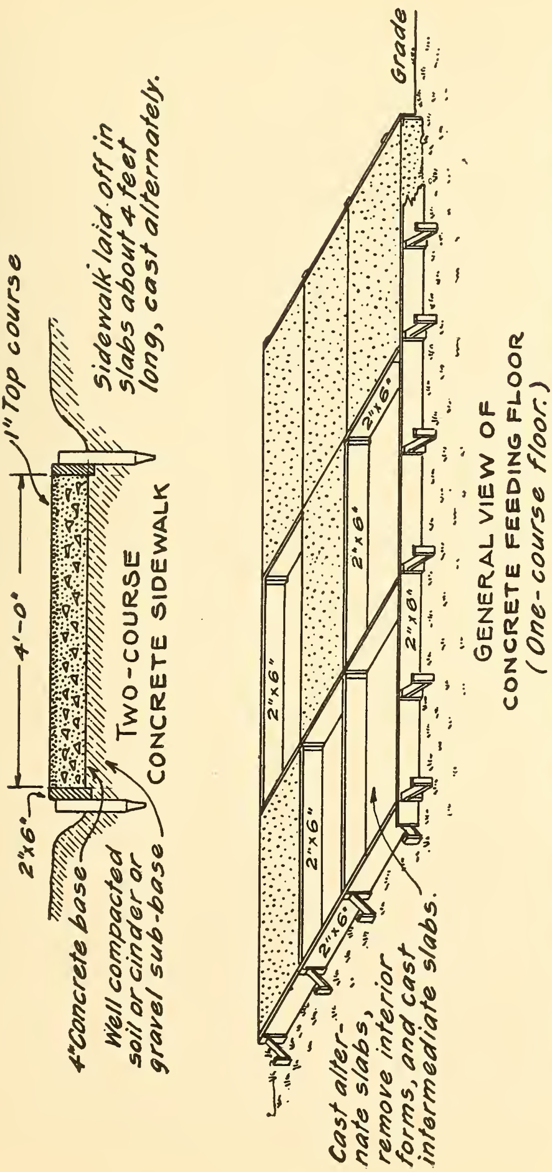
tempting to construct the entire section with respect to its surface contour at one time.

There have been many conflicting opinions advanced as to the advisability of concrete floors in dairy barns, that is, allowing the concrete surface to be exposed in the stall where the animals must lie down. It is probably true that in cold climates it is objectionable for stock to lie immediately on the concrete. Of course if bedding could always be kept in place it would prevent contact between animals and floor, but as it usually is trampled about, leaving a certain area of the concrete exposed, it is well perhaps, to lay on top of a concrete base in the stall some of the several kinds of stall paving block such as cork block, so that the animals will not have to lie on the concrete. In warm climates this is unnecessary. Certainly if the concrete is too cold to lie upon it must be because the interior temperature of the barn is too cold to be comfortable for the stock.

Concreting of feed alleyways and driveways in the dairy, horse barn, general purpose barn, or hog house is just the same as for concrete feeding floor, barnyard pavement or walks. All interior floors in stock quarters at least should be finished with a wood float to provide the even, yet gritty texture which such method of finishing secures.

There is no need of describing details of other indoor floors laid on the ground. It might be mentioned, however, that the concrete floor in the corn crib should be sloped outward so that if rain blows in between slats it will drain away quickly. Also to prevent too rapid wear of shovels when shoveling corn out of a crib the corn crib floor may be smoothed off slightly with a steel trowel instead of being left with the wood float finish.

Dusting of Floors. One might think that because the indoor floor is not exposed to sun and wind the protective covering recommended for feeding floors and other outdoor pavements is not necessary. This, however, is not the case



Section of two course concrete sidewalk and general view of one course concrete feeding floor.

because one complaint sometimes made of concrete floors is that they dust under traffic. This dusting is due entirely to the fact that the water necessary to proper chemical changes in the cement evaporated from the surface and prevented completion of these chemical changes. Under traffic a certain amount of surface will wear off and produce the dusting complained of, which could have been prevented by immediately covering the concrete and keeping the surface moist. Dusting and disintegration of concrete floors are also due to improper selection of materials and to incorrect consistency of concrete. Sand that is too fine, that is, which is not graded from fine to coarse, or sand which contains clay, loam or other foreign material, is certain to produce a concrete that will dust or wear unevenly. The same results may be expected from concrete mixed too dry or too wet, particularly if mixed too wet. The reason for this is that it takes so long for the concrete to harden sufficiently to permit finishing that in the attempt to get the required finish it is gone over a number of times usually with steel trowels, and this frequent troweling breaks up the process of crystallization in the cement while it is hardening or setting and eventually destroys its ability to resist wear.

Concrete Floors Watertight. Concrete floors and pavements are dense and watertight if the concrete is properly proportioned, mixed to correct consistency, and protected after finished. Damp floors are due almost entirely to improper proportioning of materials or too dry a concrete mixture. Special treatments to secure watertightness are not necessary if concreting has been done correctly. If, however, one insists on using any of the so-called water-proofing compounds they should be used strictly in accordance with the manufacturer's recommendations, and if these are noted carefully it will be seen that they always include what has

elsewhere been detailed as good concrete practice; namely, insistence is placed on proper proportioning and mixing of well graded clean materials.

Consistency of Concrete. The proper amount of water to use in a concrete for floor construction is about one gallon to each cubic foot of concrete in place. This, it can readily be seen, cannot be an invariable rule because of the variation in moisture content of the sand, pebbles or broken stone. But when the sand is merely damp, the one gallon to each cubic foot of concrete in place will be a very close approximation of the quantity required to produce the right consistency. Another indication of correct consistency will be that the concrete is sticky and pasty. It takes considerable "elbow grease" to compact it, strike it off and work it to the required surface finish with a hand float. If it can be floated too easily then it can be floated too quickly and this is an indication of too much water in the mixture.

Reinforced Floor Over Stock Quarters in Barns. One of the ideal details of a concrete stock barn such as the usual general purpose barn is to have a reinforced floor over the stock shutting them off from the upper portion of the barn, which is usually a haymow or storage space for other combustible contents. Many a valuable dairy herd has been saved through the forethought of the builder incorporating a reinforced concrete floor in his barn design as above described. However, no general rules other than the rules of concrete practice can be given for building such a floor. It must be reinforced in accordance with the span covered and the loads to be carried, but no barn housing stock should be built without incorporating this safeguard. Several times in the past two or three years fire has broken out in various parts of the country in barns built in this manner and in every case all of the stock beneath the floor have been saved and in some cases were not removed from

the structure during the progress of the fire. It can readily be seen that such a detail while adding somewhat to the first cost, returns its cost manyfold on the first occasion that it is put to the test of fire above.

MATERIALS REQUIRED FOR 100 SQ. FT. OF SIDEWALKS AND FLOORS FOR VARYING THICKNESS OF COURSE

CONCRETE BASE

Proportions	1:2:3			1:2:4			1:2½:4			1:2½:5		
Thickness	C	Sd.	St.	C	Sd.	St.	C.	Sd.	St.	C.	Sd.	St.
2½ in.	5.4	0.40	0.60	4.6	0.34	0.68	4.3	0.40	0.63	3.9	0.36	0.72
3 "	6.5	0.48	0.72	5.6	0.41	0.82	5.2	0.48	0.77	4.6	0.43	0.86
3½ "	7.5	0.56	0.84	6.5	0.48	0.96	6.0	0.56	0.89	5.4	0.50	1.00
4 "	8.6	0.64	0.95	7.4	0.55	1.10	6.9	0.64	1.02	6.2	0.57	1.14
4½ "	9.7	0.72	1.07	8.3	0.62	1.23	7.7	0.72	1.14	6.9	0.64	1.28
5 "	10.8	0.80	1.19	9.3	0.69	1.37	8.6	0.80	1.27	7.7	0.71	1.43
5½ "	11.8	0.88	1.31	10.2	0.76	1.50	9.5	0.87	1.40	8.5	0.78	1.57
6 "	12.9	0.96	1.43	11.1	0.82	1.64	10.3	0.95	1.53	9.2	0.86	1.72

WEARING COURSE

Thickness	1:1		1:1½		1:2	
Inches	C	Sd.	C.	Sd.	C.	Sd.
½	3.0	0.11	2.4	0.13	2.0	0.15
¾	4.5	0.16	3.6	0.19	2.9	0.22
1	6.0	0.22	4.8	0.26	3.9	0.29
1¼	7.5	0.27	6.0	0.33	4.9	0.36
1½	9.0	0.33	7.2	0.40	5.9	0.43
1¾	10.5	0.39	8.4	0.46	6.9	0.50
2	12.0	0.45	9.6	0.53	7.9	0.58

NOTE—Quantities expressed in the following units: Cement, ...sacks; Sand....cubic yards; Pebbles or Broken Stone....cubic yards.

BUILDING BLOCK

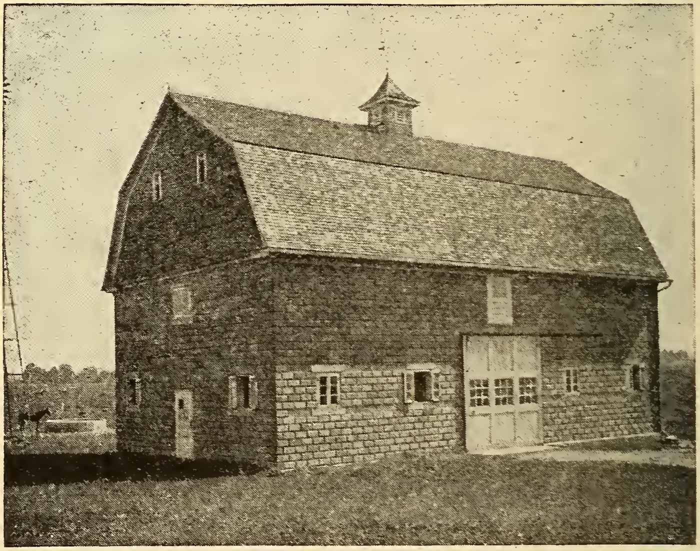
Early Use. No doubt a great deal of the widespread popularity which concrete now enjoys as a building material on the farm is due to the extensive use made of concrete block. As sometimes happens, however, the manufacture of a good product in a general way often falls to those who fail to observe requirements that lead to success and some years ago concrete block suffered in reputation solely because many people thought concrete block making easy or they were not willing to apply the principles of good concrete practice. They did most of the things that should be avoided or failed to observe the essentials leading to success. Fortunately this early condition has about corrected itself.

Merits of Block. Like all other concrete work, concrete block appeal strongly to the home worker because all materials excepting the cement are usually near at hand and can be obtained for little more than the labor necessary to dig and haul them. Scarcely any community is without the sand and pebbles required for aggregate. Still another appeal made to the home concrete worker by concrete block is that they can be made in small quantities at odd times and little by little in this manner a stock of first class building material may be accumulated that can be used during other convenient intervals to build sanitary, fire-proof, rat-proof buildings of all kinds.

Molds and Machines. Only little equipment is required for block manufacture if they are to be turned out in limited quantities. Anyone with average carpenter skill can make several home-made molds following a de-

sign similar to that shown in accompanying sketches. A sand and gravel screen will complete the equipment necessary to provide a means for profitably using spare time on rainy days.

If, however, considerable building is to be done, the speed of manufacture will be limited by such molds and it may be advisable to purchase one of the various types



A good example of the use of concrete block in barn construction.

of block machines now on the market, some of which can be obtained for as little as $50 and can be relied upon to turn out thoroughly satisfactory block. As a matter of fact, this item of cost is not a large one and will readily be absorbed if any number of structures are to be built or any considerable number of block are required.

If a machine of greater possibilities and capacity is desired, several farmers can unite as in the case of pur-

chasing other concreting equipment and can get one of the higher priced machines which can be devoted to community use.

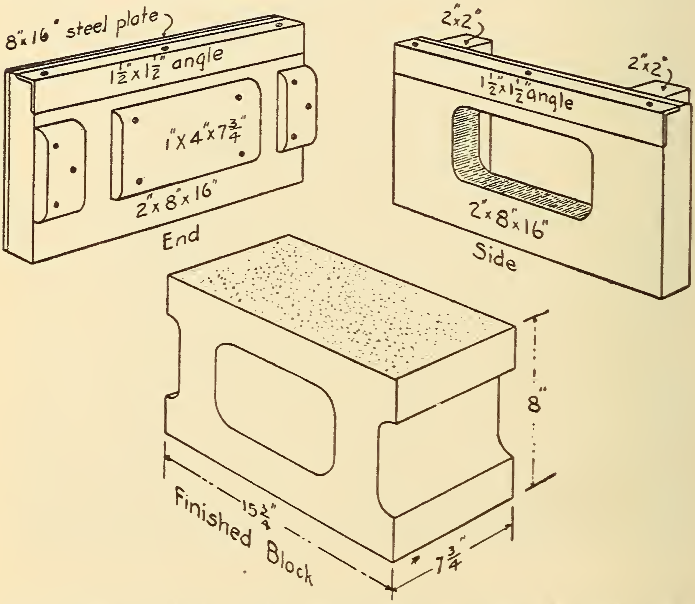
In using the home-made mold shown, after the concrete has been placed in the mold and tamped to the bottom of the core openings, the two cores are inserted and concrete placed and tamped around and above them. Cores should be made from three thicknesses of wood, fastened together by long screws and the grain of the wood should run in opposite directions so as to prevent warping. In order that such a home-made mold may be more durable and that the finished block may have a better surface appearance, the inside face of the several parts of the mold should be lined with galvanized iron. This will not only assist to prevent the wood from warping, but will make removal of the block from the mold easier.

Oiling Molds. All parts of the mold against which concrete is placed should be oiled at each filling with a mixture of kerosene and raw linseed oil.

Mixtures to Use. Clean, well graded sand and pebbles, properly proportioned mixtures, just the right amount of water, thorough tamping of the concrete in the form, and proper curing or hardening of the finished product is equally as important in concrete block manufacture as in any other use of concrete. Some people follow a wrong practice in making concrete block from a mixture consisting of 1 part cement to 4 or 5 parts of sand. Block made of concrete thus proportioned will be weak and are certain to be porous. The proper proportions for ordinary concrete block are 1:2½:4. Ordinarily the maximum size particles or pebbles or broken stone should not exceed ¾ inch in greatest dimension. A properly graded mixture like this, providing the correct amount of water is used, means that the concrete block, and con-

sequently the wall built of them, will be watertight if mortar joints are well filled.

When materials have been thoroughly mixed, the concrete should be placed in the mold little by little and as placed thoroughly tamped so that a slight flushing of water to the surface will be evident. A word of caution may be given here concerning the far too common tend-



Some details of home made concrete block mold and a sketch of the finished block cast in this mold.

ency of block makers to use less water than is required for best results. Of course, for production in reasonable quantity, the block must be removed from the mold immediately after manufacture so the concrete mixture cannot be so wet that the blocks will fail to retain their shape when removed from the mold. However, the general tendency among those making concrete block is to use so little water that the resulting block are porous.

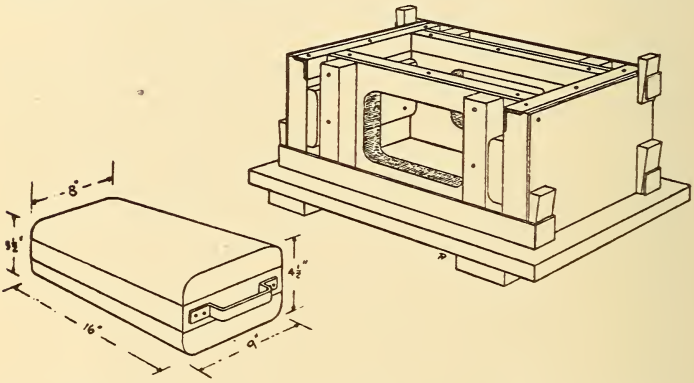
Curing the Product. "Curing" is the term used to refer to the final process which block must undergo to gain proper strength. In large commercial concrete product plants the block are steam cured just as has been mentioned elsewhere in connection with concrete drain tile. However, the average home worker cannot equip himself with facilities to cure concrete block in this way, so it is necessary for him to resort to other means of properly hardening the product.

The place used to manufacture them should be a tight shed or cellar so that when the block are removed from the mold they can be protected from wind and sun and in addition be covered with wet straw, hay or burlap to prevent them from drying out too rapidly. This covering should be kept wet for several days, say a week or more, after which it may be removed and the block piled out of doors to finish hardening under natural conditions. If the precautions outlined are followed, the block may be used in any ordinary construction 30 days after manufacture, but should not be used before that time has elapsed.

Laying Up in Walls. Before laying concrete block in a wall they should be thoroughly saturated by immersing them in water or drenching with water applied from a hose. Ordinary sprinkling will not do. This wetting is necessary to keep the dry block from absorbing so much water from the mortar in which they are laid as to prevent the mortar from firmly uniting with the block faces and thus producing tight joints. Particular care is necessary to insure joints being thoroughly and uniformly filled with cement mortar. Mortar for laying block should be mixed in the proportion of 1 sack of portland cement to 2 cubic feet of clean, well graded sand. It is permissible, but not necessary to mix with this an amount of hydrated or thoroughly slacked lime

not exceeding 10% of the weight of the portland cement used. Lime does not add to the strength of the mortar but makes it fatter, as masons say; that is, it works more readily under the trowel. Mortar joints should average about ⅜-inch thick.

Some Uses of Block. Among the more recent uses to which concrete block have been found especially adapted is the building of corn cribs. This class of



Assembled form for home made concrete block and sketch of core form used to cast blocks below.

structure of course requires a special type of block in which there are openings to permit ventilation of the stored contents.

Several manufacturers of concrete block machines make metal molds for making corn crib block. When the farmer has provided himself with a corn crib block mold and a mold for making standard types of concrete building block, he is prepared to manufacture any building needed on the farm except a silo.

Among the particular applications of hollow block construction the milk house and the ice house may be mentioned as conspicuous examples of concrete block efficiency. The hollow spaces introduced in the block

provide air cells in the finished wall which tend to insulate the inside of the structure from sudden outside temperature changes. In this way the interior may be kept at a reasonably uniform temperature.

Surface Finish. In some types of structures, particularly residences, it is often desirable to vary the plain surface appearance of the concrete. During the past few years some very pleasing effects have been accomplished in surfacing concrete block with various selected materials such as crushed granite, crushed marble of various colors, mica, quartz, crystals, or several of these combined. The method of using these surface coatings is relatively simple. The block are laid face down in the mold or machine, the material selected for the facing material is prepared by using 1 part of portland cement to 1½ or 2 parts of crushed material such as marble, quartz, crystal, etc. Place ¼ to ½ of this mixture in the mold and then fill with the regular concrete mixture. Care should be taken that both mixtures are of a uniform consistency so that they will firmly unite.

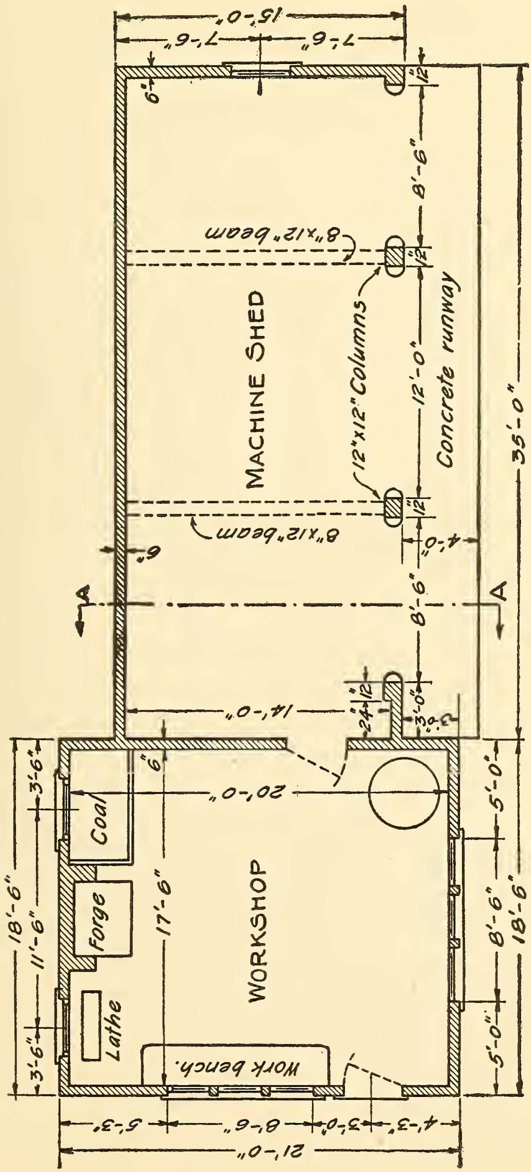
More details of surface finish for concrete applicable also to concrete block are given in another section treating of surface finish of concrete.

HOUSING FARM IMPLEMENTS.

Sun and rain are largely responsible for the rapid depreciation of farm implements left exposed to the elements after use. On far too many farms today the plow, harrow, cultivator and grain drill, harvester and even more expensive implements are left at the end of the last furrow or row, or in the field where last used, exposed to the elements until wanted for the next season's use. In

Monolithic concrete implement or machine shed.

attempting to limber these up for the required efficiency when the crops of another season must be cultivated or harvested, it is usually found that rust has tightened parts so that something must be broken to start things going or sun has split woodwork so that it is all but useless. It is this neglect which causes any implement to depreciate more rapidly than any kind of normal use associated with proper care. A number of the large man-



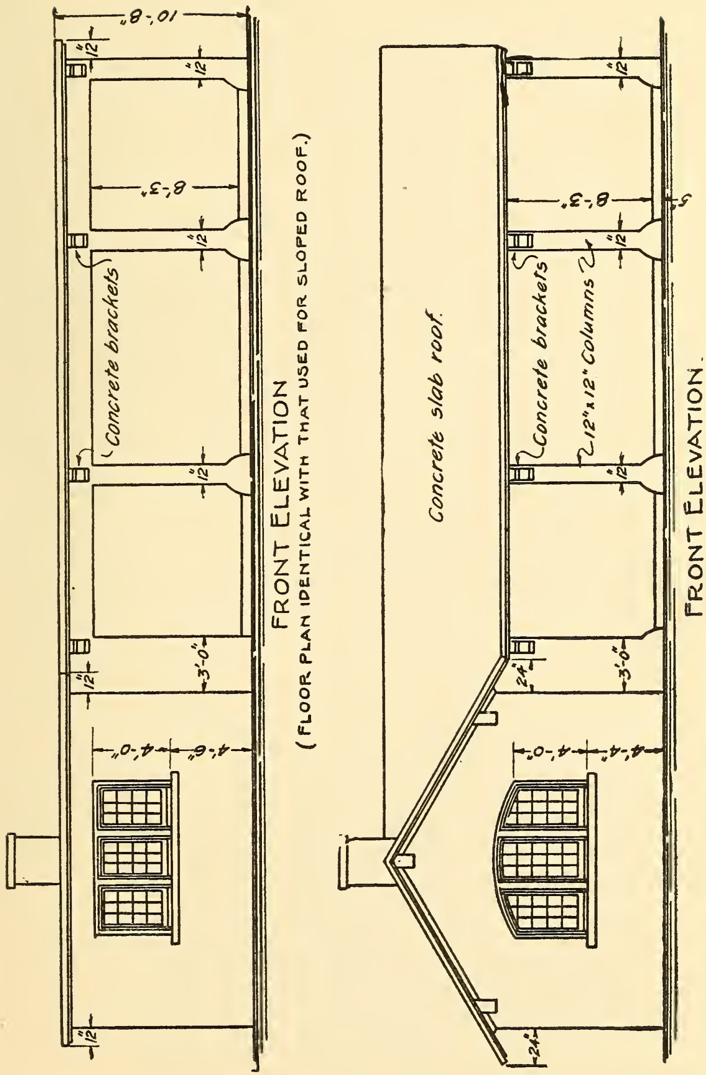
PLAN
Plan of concrete machine shed with workshop attached.

ufacturers of farming implements have compiled figures showing the rate of this depreciation of farm machinery resulting from exposure to the weather and general improper care or abuse, and they have almost uniformly reached the conclusion that 75 per cent of depreciation is caused by exposure and only 25 per cent from the wear and tear of actual use.

On too many farms there is no suitable place to store machinery. Of course on some farms there is a limited amount of storage space available in some of the buildings or on the barn floor but implements run into these buildings are often in the way when indoor chores must be performed during bad weather so must be moved from time to time to permit carrying on such work.

The only logical solution of the machinery proposition on the farm is an implement shed. The wonderful improvements in farm machinery of all kinds resulting in farm implements demand that machinery be protected
in farm implements demand that machinery be protected
and cared for in a building provided exclusively for such purpose. A machine shed need not be an elaborate nor expensive structure, but, like all modern farm buildings it should be of permanent construction and fireproof. Probably concrete is the cheapest in the end because of the protection it will afford to the implements housed in it and from the fact that as a structural material it is proof against depreciation common to other building materials and which causes such costly and continuous maintenance.

Although the exact number of automobiles owned by farmers is not definitely known, it is certain that the number is large and it is rapidly increasing. Recent estimates place the number of automobiles in the United States at about 6½ million and it is estimated that this total will have grown to 8½ million within the next two



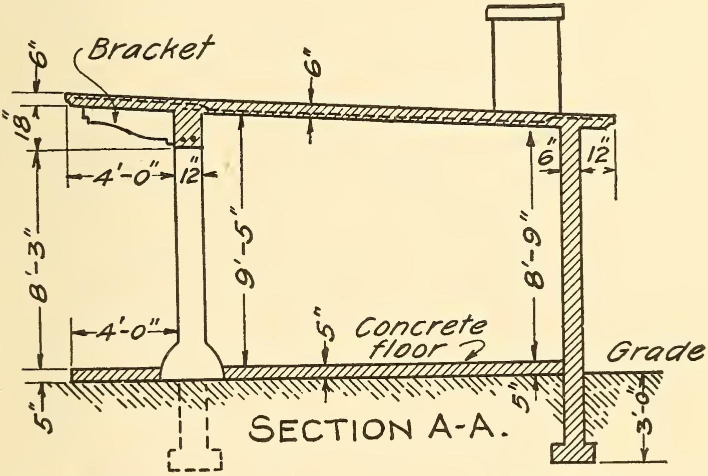
Alternative elevations illustrating flat and pitched roofs for concrete machine shed.

years. At the present time manufacturers say that from 60 to 70 per cent of their output goes to rural owners. From these figures it may be inferred that within the two-year period mentioned, farm-owned automobiles will outnumber those owned in the cities and towns. Then there is the tractor which is just coming into its own. Outdoor storage is no better for the tractor than for any other implement and while it may be true that few farmers would think of leaving the tractor nor the automobile out of doors, it is a fact that one or two other implements that are left so exposed are frequently equal in value to the one or two so carefully housed. Every tractor should be given proper shelter and so should every automobile and since there are a number of things to be considered in providing this shelter, it is well to study ways and means by which it may be secured.

The farmer uses his tractor not only for plowing, planting, mowing and harvesting, but for sawing wood, threshing and other minor power needs on the farm; therefore the implement shed should be so built that the quarters provided for the tractor may be convenient for running belting to a line shaft and thereby providing the machinery necessary to a workshop which can be quartered in one end of the implement structure. At very little extra cost the implement shed can be made large enough not only to hold the tractor and automobile but the farm motor truck, a vehicle that is also becoming a common piece of farm equipment.

Every farm needs a workshop where simple repairs can be made to the farm implements without the necessity of going to the nearest town for a mechanic, whose services would not be needed if the farmer were equipped to do what a mechanic is usually called in for. Nothing can destroy property more rapidly than fire and in planning an implement shed, this fact should be kept fore-

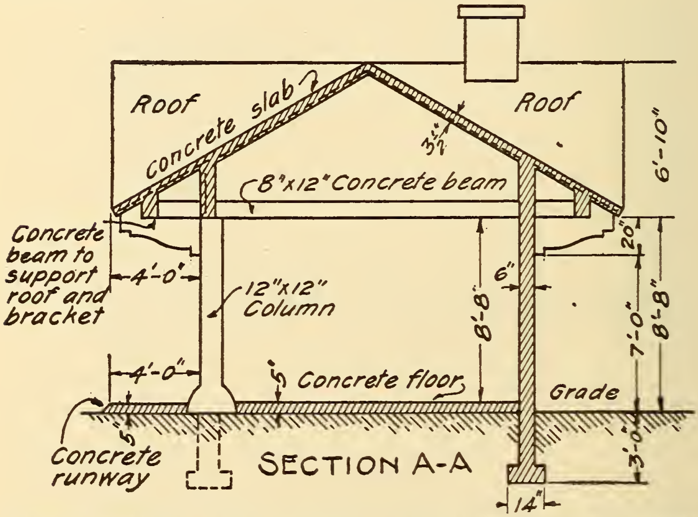
most in mind. Too frequently there is displayed the ill-advised practice of erecting a structure usually cheaper in itself than one of the implements it is supposed to protect. Even the cheapest piece of mechanical equipment on the farm represents considerable investment, and protection should be afforded both from within and from without.



Transverse section through concrete machine shed showing various dimensions where flat roof is used.

In general, it may be said that an implement house or shed should be a low structure with a clear height of 8 or 10 feet and a depth from front to back of at least 16 feet. Length will be governed entirely upon the quantity or number of implements to be housed. The front should preferably face east. Arrangements should be made to close the front against severe storms. This can be done by hanging curtains of canvas on rollers so that these can be held down when occasion demands. Several interior appointments will make the shed more convenient and useful. At one end there may be a combined garage and workshop; at the other a separate housing

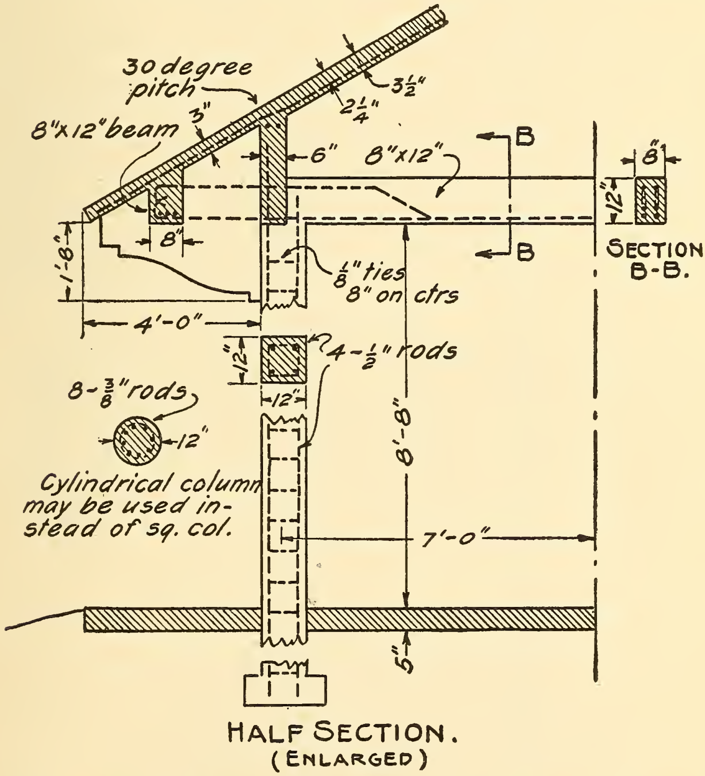
for the tractor. Where an automobile or motor truck is kept, there should be a pit in the floor, making it convenient to get at and repair machinery from underneath or to clean the machinery. Such a pit should be from 3 to 4 feet deep and 3 feet wide and 4 to 5 feet long. The garage quarters should be floored with concrete. The implement shed, proper, needs no floor but should be filled in enough with well compacted gravel containing plenty of sand, so that the soil will drain freely.



Transverse section through concrete machine shed showing various dimensions where pitched roof is used.

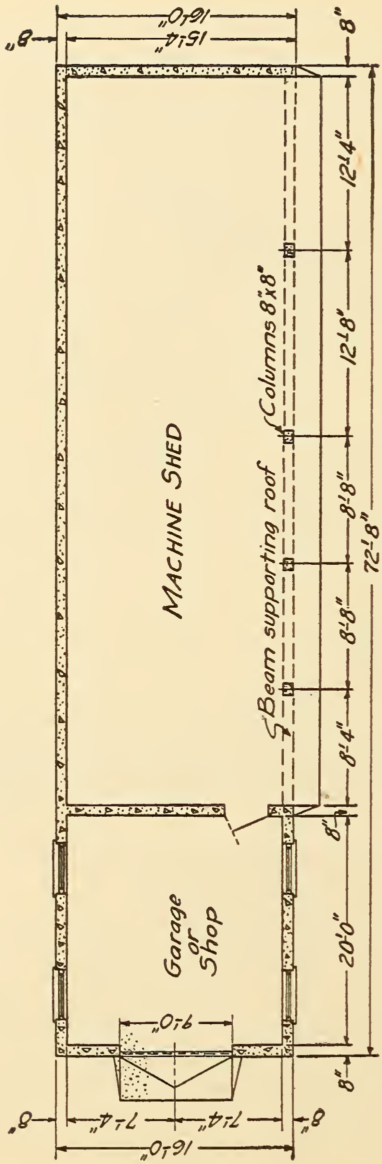
Accompanying sketches suggest an implement shed designed to be of reinforced concrete. The walls should be 8 inches thick and should be reinforced with ⅜-inch round rods placed every 2 feet, vertically and horizontally. Corners should be tied in by 4-foot lengths of rod bent around corners and laid every foot or 18 inches horizontally. Two rods set diagonally with each corner of window and door openings should also be placed in

the wall to prevent cracking at these points. Concrete block also may be used for wall construction. In such case no reinforcement will be required except in lintels over doors and windows. Large sliding doors or swing-



Half section of concrete machine shed showing details of concrete roof construction and columns.

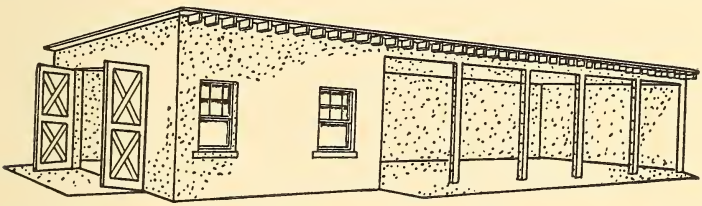
ing doors as shown in the drawing may be provided for the garage. They should be of light iron or wood, covered on both sides with galvanized iron. If swinging doors are used, the eyes for hinges should be embedded in the concrete while it is being placed in the forms, or



Plan of farm machine or implement shed with garage or workshop as an adjunct.

in the case of block construction, should be firmly anchored in the mortar joints between blocks when the latter are laid.

A roof that will be fire-resisting may be built by using one of several composition roofing materials now on the market. Such a roof should have a pitch of not less than 1 to 5. The ceiling may be built by nailing upon the lower side of the joists, metal lath on which one or more coats of cement plaster should be placed. In the accompanying drawing, the 2 by 10 roof joists are shown with exposed ends, merely to indicate more clearly the details of construction. In finishing the structure, these ends should be cased in with metal lath and this in



Perspective sketch of the structure last shown in plan.

turn covered with cement plaster, giving a more finished appearance and more effectively guarding against fire.

The farmer who has had reasonable experience in home concreting will not find it difficult, with his farm laborers, to build a machine shed that will meet his needs, using either block or monolithic construction. The steel frame and cement plaster method usually referred to as stucco requires a little more than average skill, which will prevent choice of this type of structure unless outside workmen are called in to build it.

There should be a gasoline engine set up conveniently to operate any machine tools that are needed, a small forge for ordinary common blacksmithing. Somewhere adjacent to the machine shop or workshop and entirely

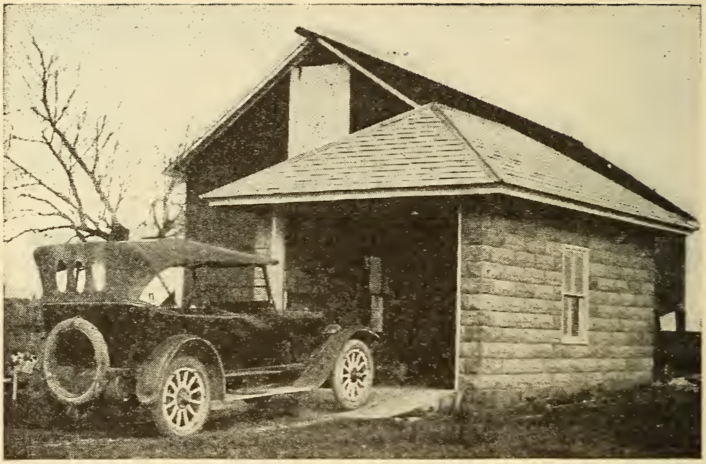
outside of both, there should be buried in the ground a steel gasoline storage tank in which the necessary supply of fuel can be kept safe against exposure to fire. Because of the rapid corrosion of steel in the ground, the gasoline tank should be completely encased in 6 inches of 1:2:3 concrete. A gasoline pump should be connected so that fuel required can readily be drawn from the tank. Pipe and pump connections should be part of the tank equipment and should lead into the shed or workshop, although the inlet for filling the tank should be out of doors.

A CONCRETE GARAGE ON THE FARM.

One farm building problem that demands careful thought and suitable execution is the building of the garage. Here is a structure relatively cheap in itself but often containing property as valuable as the entire contents of the residence, and owing to the storage of oils, grease and gasoline that are a necessary part of the stock of supplies kept for operating the car, property is continually exposed to the danger of destruction by fire.

Arrangements should be made when planning a garage to extend the house heating system to the structure where either steam or hot water heating is employed so that an independent heating plant in the garage will not be necessary. If this cannot be done then the discomforts of having the garage unheated should be put up with because of fire risk.

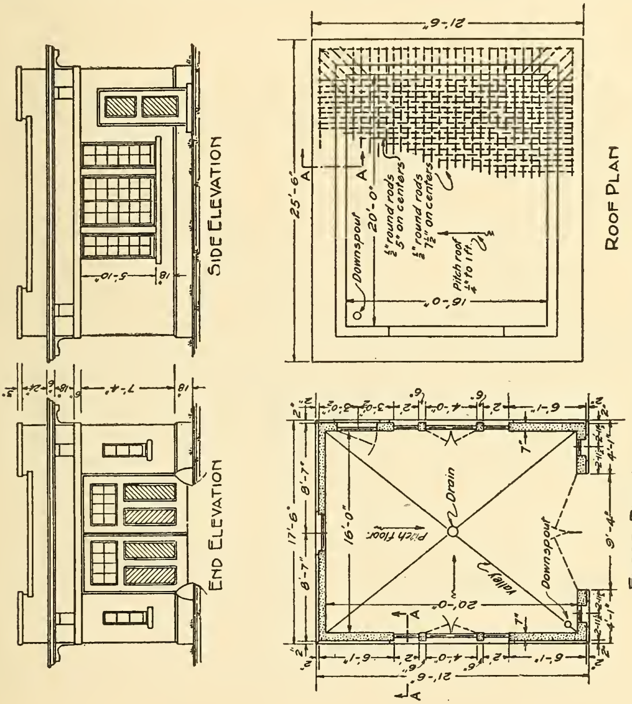
A little thought will suggest several conveniences or working facilities that will increase the utility of the finished structure. One of these consists of a repair pit which may be 4 feet deep, 4 or 5 feet long and say 3 feet wide. The car can then be run over this, making it easier to examine or repair machinery from underneath the car. Machinery can be kept somewhat cleaner and the tires more nearly free from exposure to oil if the runways on which the machine enters the garage are elevated two or three inches above the floor grade. Outside the garage there should be an underground gasoline storage tank encased in 6 inches of concrete and equipped with a gasoline pump. Arrangements for filling the tank should be entirely outside the garage.



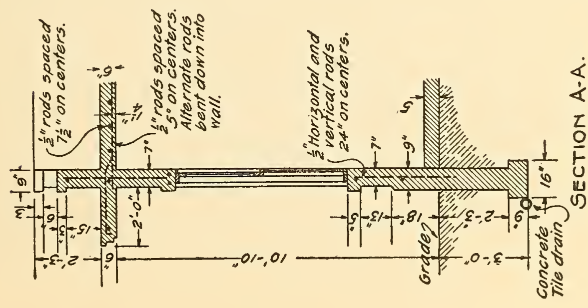
Small farm garage of concrete block.

Concrete block garage.

The garage floor should be sloped to a drain to permit carrying wash water away when washing down the car. In laying the floor drain sufficient fall, at least 1 foot in 100, should be provided and the entrance to the drain

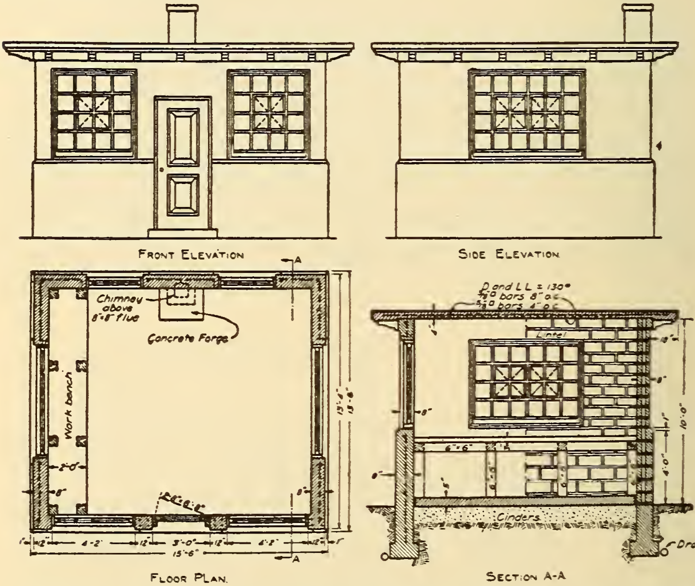


Plans and elevation of small concrete garage.



Section through wall showing details of reinforcement.

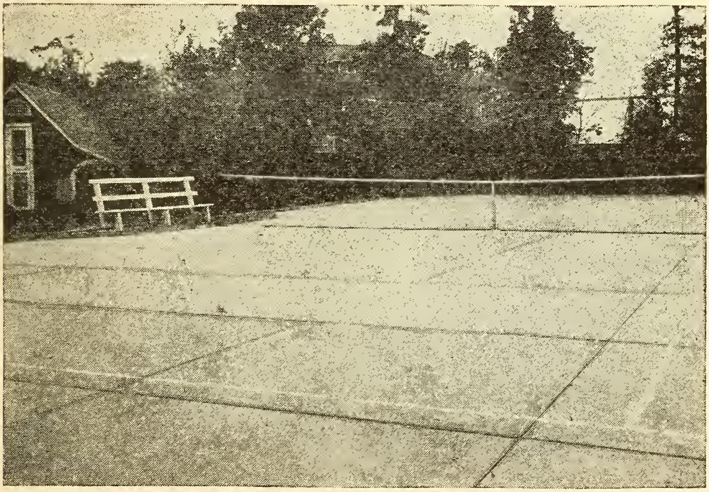
should be covered with a grating so that refuse cannot enter and clog it. A work bench conveniently located with respect to some window so that there will be plenty of light on the bench will be found an added convenience. A locker room may also be provided for car accessories and extra parts.



Suggested design for small concrete workshop that can be built either of monolithic concrete or concrete block or may be used as a small garage.

TENNIS COURTS.

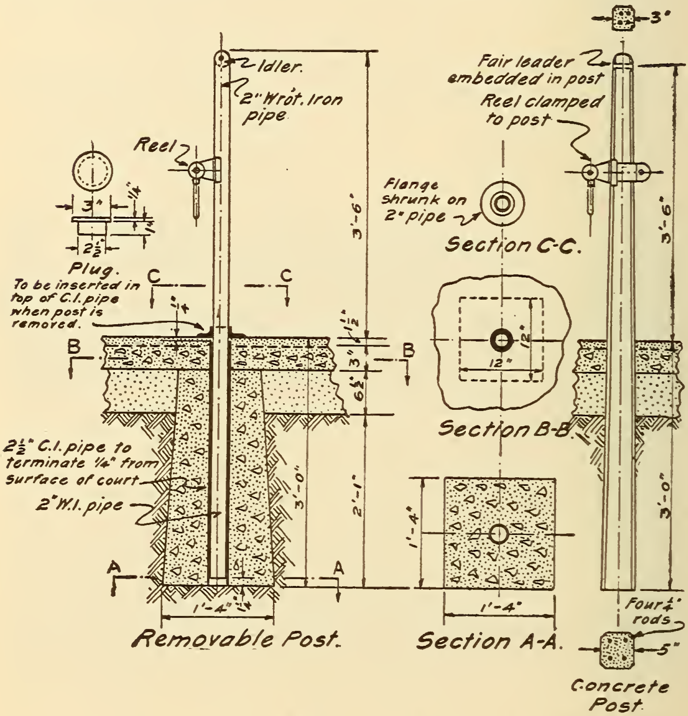
Many persons may regard the concrete tennis court as representing a rather novel extension of use for concrete and likewise might be inclined to advance a number of objections to the concrete court which in reality is nothing more nor less than another adaptation of the concrete pavement. A few years ago there were not



An example of a private concrete tennis court on a suburban estate near Chicago.

many concrete tennis courts in the country but those which were in use soon proved the best advertisement for this use of concrete and today there are probably hundreds of such courts throughout the country as an adjunct of clubs and as an appointment of private grounds.

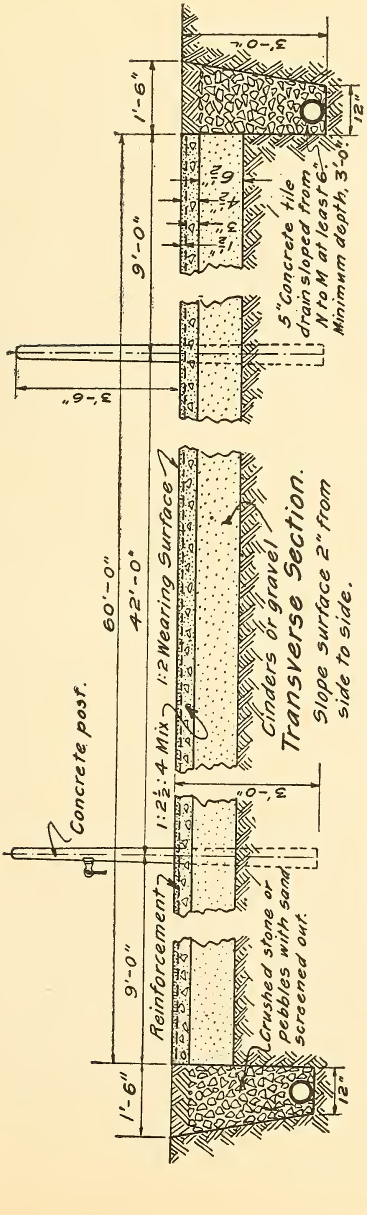
Briefly, the advantage of the concrete court is that it is ready for play any time of the year. It requires none of the rolling and dressing up or other continual maintenance necessary to turf or clay courts and because of the very nature of the surface permits speedy play.



Some details of setting posts to string net on tennis court.

Natural soil and grass courts require some daily expenditure of labor and money to keep them in suitable condition for play and there are times when, regardless of the best maintenance, such courts cannot be used because of weather conditions.

Location. In planning to lay out a tennis court a location should be chosen that will afford sufficient area

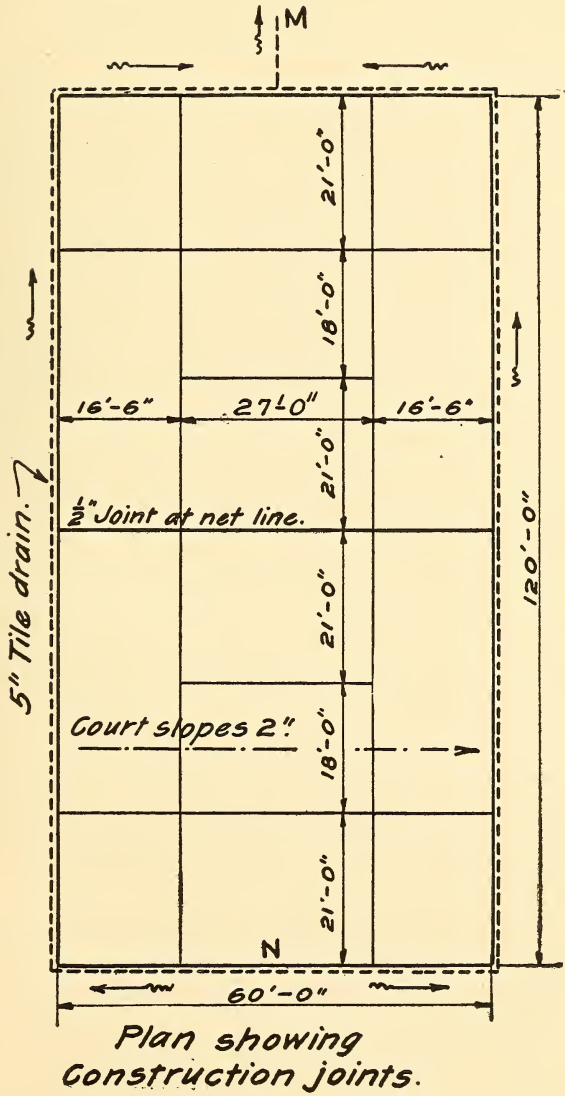


Traverse section of concrete tennis court showing various dimensions, position of reinforcement and drain line around court.

to pave outside or beyond actual court lines, thus giving ample room for the players. Foundation requirements are similar to those outlined for other concrete pavements and must be made in accordance with the conditions of soil and location involved. Suitable provision must be made for foundation drainage, this being necessary principally to prevent water from being retained beneath the pavement and causing the consequent heaving resulting from freezing and expanding of water.

Plan for Court. Accompanying sketches show layouts for a concrete tennis court 60 by 120 feet and give details of various parts of the construction. It will be noticed in one of the sectional sketches that a drain is shown at each end of the court. This is provided to take care of surface water running off the court. This drain consists of a 5-inch line of tile running around the court as shown by the dotted line around the plan. The tile lines should be so laid as to drain in the directions indicated by the arrows. In backfilling the trench in which the tile are laid gravel or broken stone should be used up to within a short distance of the ground surface so that water can readily find its way to the drainage system.

Construction Requirements. General concrete pavement construction considers careful preparation of the subgrade. This involves digging out all soft spots and filling them with clean material which should then be thoroughly compacted. Following this the whole foundation area should be rolled to uniform firmness. The subgrade or foundation on which the concrete is to be laid for a tennis court should be prepared in the same careful manner. On top of this prepared subgrade there may be laid a subbase of well compacted gravel or cinders provided the location is such that trouble may be expected from water likely to be otherwise retained under the

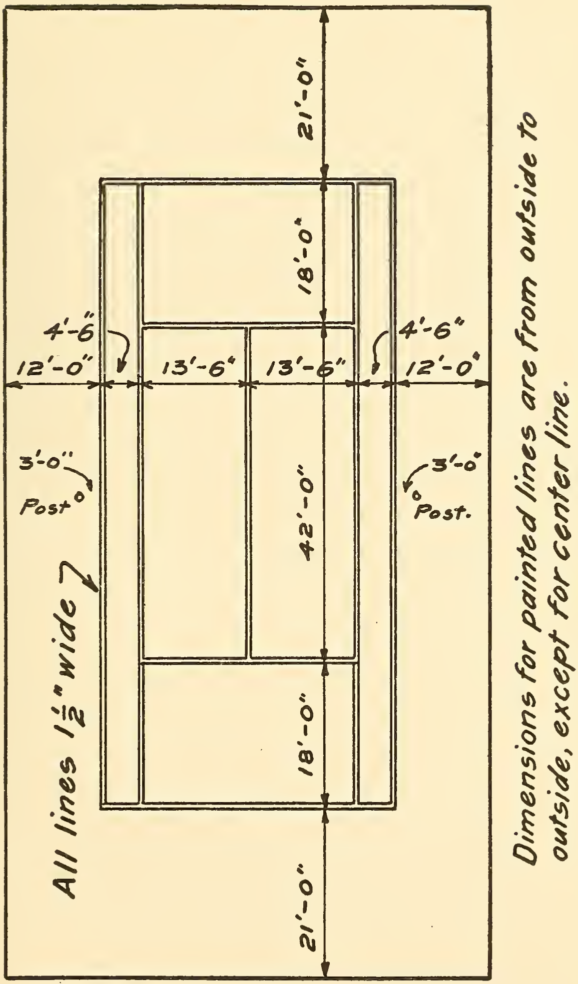


Plan showing concrete joints in concrete tennis court.

pavement. If the soil is of sandy texture and therefore likely to be free draining this subbase will not be required. When a subbase is used it must be properly connected to tile lines to prevent retention of water beneath the concrete. Of course when a gravel or cinder subbase is necessary the site of the intended foundation must be excavated enough so that the finished pavement surface will lie at a proper level in relation to the court surroundings. It is good practice, however, to grade the ground up to the court so that the court surface will be somewhat above the greater portion of the surroundings. This will insure better drainage of the foundation.

Forms. Forms should consist of 2-inch material of suitable width laid true to line and grade, the latter to provide for a slight pitch in the pavement from the net line toward the back of the court, thus insuring quick drainage of the concrete surface following rain. Probably a pitch of 1 inch in the distance from the net line to court lines will be sufficient for each half of the court. Provision should be made to use the joint between sections at the net line as an expansion joint, this being done by placing a wood or metal strip about ½ inch thick where this line is to fall and after concrete has been placed removing the strip and filling the joint with hot tar or asphalt. Also arrangement should be made to embed a ring at the middle of the court along the net line for fastening the tape that holds the net in proper position at its center.

Thickness of Slabs and Reinforcement. Concrete slabs composing the court should consist of a 3-inch base with 1½-inch wearing course, making the total slab thickness 4½ inches. In other words, the tennis court should be of two course construction because of the requirements to be met in surface finish. The 3-inch base should be composed of 1:2½:4 concrete, in which



Plan showing painted court lines.

the coarse aggregate up to 1½-inch in maximum dimension. The top or wearing course should consist of a 1:2 cement mortar in which the sand is coarse and well graded. Slabs should be reinforced with ¼-inch round rods spaced 12 inches center to center each way or with suitable mesh fabric or similar material having an equivalent cross sectional area of metal. After placing the base, reinforcement should at once be properly spaced and pressed into the fresh concrete and the top or wearing course immediately laid to insure a perfect union between base and top. If mesh reinforcement is used it should be placed lengthwise of the section and lapped 4 inches, or the width of one mesh. Reinforcement must not be continuous across joints as slabs must be laid independent of one another. Then any unequal settlement or heaving that may possibly take place will not crack or otherwise injure the slabs.

Placing Concrete. In mixing the concrete it should be made as stiff as possible to work it. The base, however, may be made somewhat wetter than the top or wearing course. If the top course mortar is made as stiff as can be handled it will work up sufficient additional moisture for free finishing by being floated into place. Concrete should be carefully placed to produce a fairly level surface, thus insuring a uniform thickness of slabs. After the surface has been struck off and floated evenly with a wood float it should be finished fairly smooth with a steel trowel but care should be used not to overtrowel and thereby make the surface too smooth and hence slippery.

Marking Court Lines. Court lines may be permanently marked in the concrete by inlaying a white cement mortar in a groove provided by making suitable arrangements when slab forms are staked to position, or the court lines can be marked on the concrete surface by

painting. However, painted lines will need renewal from time to time and the inlaid ones will be permanent. The whole court must be covered after concreting has been finished with a protective layer of earth kept wet for a week or ten days to enable the concrete to cure properly.

Some objection may be made to the possibility of the finished surface causing excessive light reflection during bright sunny days. The natural gray of cement finish may be darkened by adding one pound of lamp black to each sack of cement used in the wearing course.

POULTRY HOUSES OF CONCRETE.

On the average farm, poultry is kept simply as an adjunct of the kitchen or as a source of pin money for the women folks. Under usual conditions found on the farm poultry rarely if ever yield the returns that would be possible if given the same care and attention as are devoted to other farm animals which are regarded as more or less of a specialty.

An example of the use of cement staves similar to those used in building cement stave silos for poultry house construction.

In these days of back-to-nature and open-air poultry houses, concrete offers some distinctive advantages for poultry house construction. Fowls can withstand very dry cold if well housed but cannot long thrive where dampness and drafts prevail. The board or dirt floor is not a good stamping ground for poultry in cold weather. If the poultry house happens to be built of frame throughout, such a structure cannot be kept sanitary.

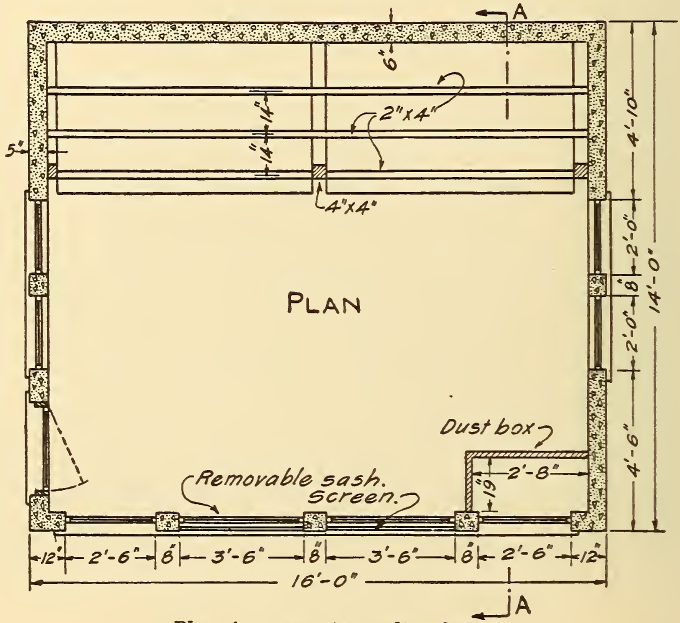
It soon becomes the finest kind of a breeding place for lice which infest the fowls housed under such insanitary conditions and very greatly restrict the egg output. Every poultry house needs thorough disinfection from time to time, for on such disinfection largely depends the health of fowls and the profit of keeping them. Just as fruit trees require spraying at regular intervals for maximum fruit yields so the hennery requires frequent attention.

A good example of the combination of monolithic concrete and concrete block in poultry house construction.

Concrete Highly Sanitary. Certain building materials afford less attraction to vermin than others. Wood construction harbors every kind of filth and vermin and can hardly be efficiently disinfected. A concrete floor eliminates part of the trouble but it is best to have walls also of concrete. The hard impervious surface can easily be washed down and thoroughly disinfected by an occasional coat of whitewash and offers the best

possible solution of desirable environment for fowls both in winter and in summer.

Location. A poultry house should be located on soil that is either naturally dry or may be properly drained by artificial means. A slight rise of ground providing a southern exposure to insure plenty of sunlight is best. Buildings which face the south get the greatest exposure

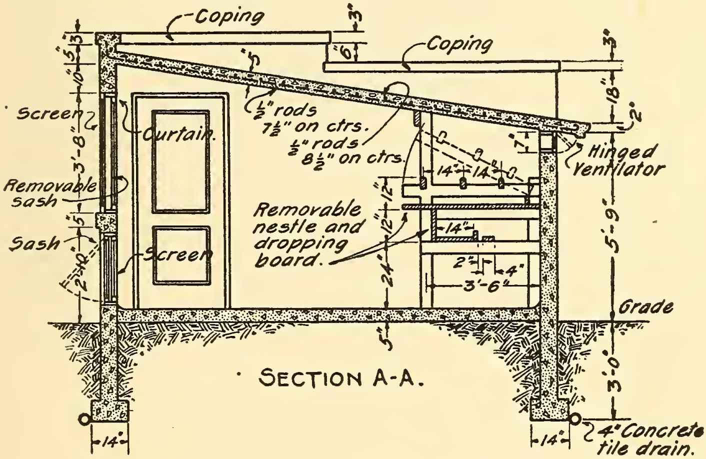


Plan for concrete poultry house.

to the sun's rays and in other respects are warmer, drier and generally better than buildings not so located. If impossible to place the poultry house so that the main exposure is south then an eastern exposure is preferable to a western one as the morning sun is much more agreeable than afternoon sun.

Two prime requisites of successful poultry raising are plenty of sunlight and good ventilation. Most poultry

houses lack sufficient ventilation, which is of greater importance than sunlight. Plenty of air insures the health of poultry but arrangements for ventilating the structure must always be such that drafts will be avoided particularly in the section where the roosts are placed. Dampness in poultry houses, especially in cold weather, is generally the result of insufficient ventilation. An

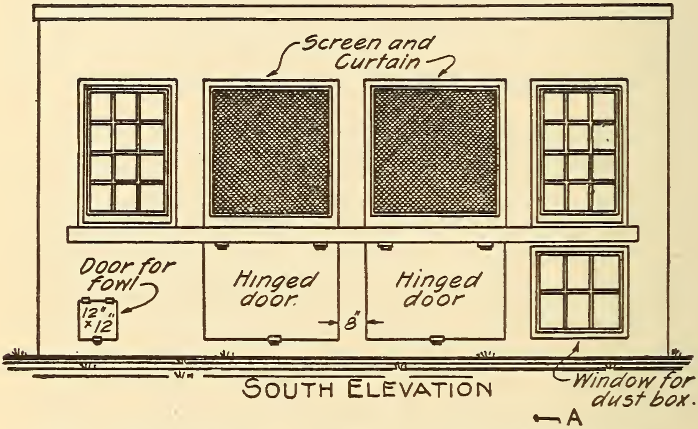


Section of concrete poultry house.

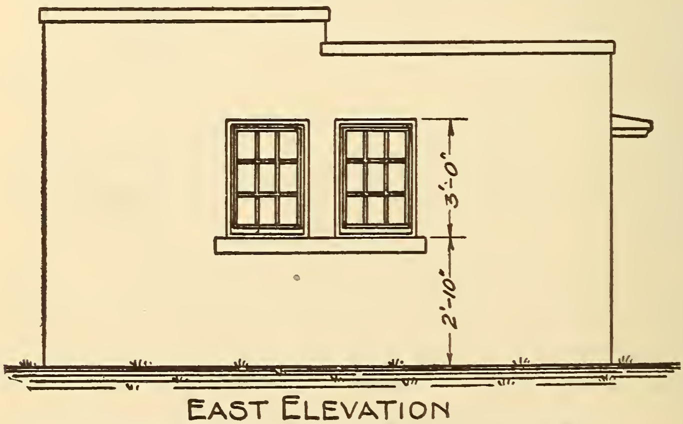
indication of this will be the formation of condensation of the walls from the vapor laden air of the breathing fowls.

Disease germs cannot thrive where sunlight is a long and frequent visitor and the value of sufficient window openings in poultry houses cannot be overestimated. One should remember, however, that while a house without plenty of sunlight is likely to be damp and dreary, a house containing too much glass frontage will be hot during summer and extremely cold during winter nights. The best method of securing proper light and ventilation is to use a combination of cloth and glass windows. Roof or wall ventilators may also be used in connection

with such windows if desired. About one square foot of window area to 10 square feet of floor area equally divided between cloth and glass windows is generally sufficient to give good light and ventilation.



Front elevation showing glazed and cloth covered openings.

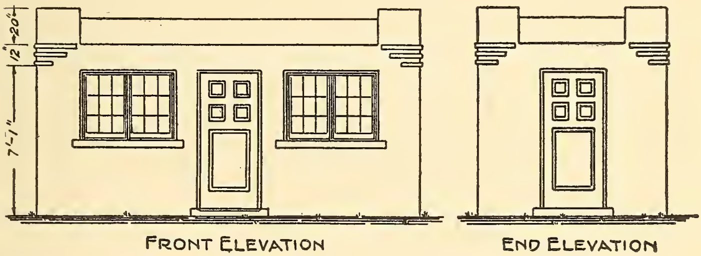


Suggested end elevation for concrete poultry house.

Poultry houses should be so built that thorough cleaning of them will be easy. Wall surfaces should be made smooth and free from projections. If care is

taken when placing concrete block or building monolithic concrete, a smooth wall surface can be produced without need of any other finish in the form of plaster. Windows should be so located that they may be kept as free as possible from accumulations of litter.

Size of House. In determining the size of the house consult the recommendations of the various bulletins issued by State Agricultural Departments on the subject of poultry raising. As a rule it is better to allow too much floor space than too little. The larger the pen



Suggested front and end elevations of concrete poultry house

the less floor space will be required per fowl. One hundred hens will thrive in a pen 20 by 20 feet. Above all, poultry should not be crowded, as when kept in close quarters the lack of room for exercising results in considerably decreased egg production.

A concrete floor is a very desirable feature of a poultry house because with it in combination with a concrete foundation, the poultry house becomes easier to clean and keep clean. It may be laid as soon as the foundation is in place and should be placed at sufficient height above level of outside ground to prevent water from running in. Such floors should never be left bare when in use. They should be covered with about 3 inches of sand or earth, which should be replaced as often as necessary to keep it from becoming sour from accumulations of drop-

pings. On the sand or earth covering of the floor there should be placed several inches of straw which in addition to providing warmth makes it necessary for the fowls to scratch for their feed which should be thrown to them in the straw, thus forcing them to take the necessary exercise.

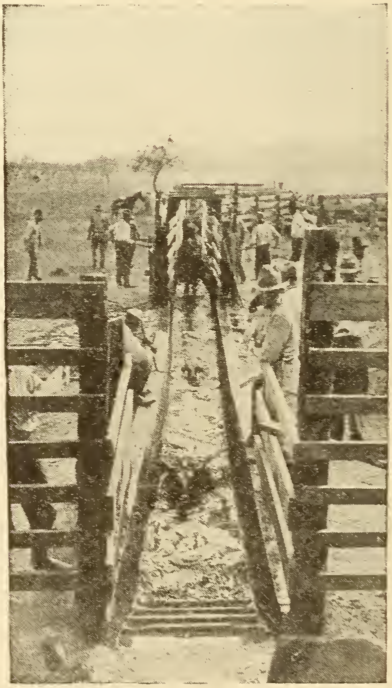
No matter how cleanly the surroundings of a poultry house may be as regards freedom from lice, fowls like a wallowing place, and a sand bath is a very desirable appointment of the poultry house. A small area should be curbed off in one corner of each section of the house to be used as a sand bath where the fowls may wallow at pleasure. Sand within this curbing should be kept dry and clean and as an aid to this a little finely powdered coal ashes may be mixed with it. Some persons use ashes only in the wallowing box, but as these unmixed with sand attract moisture more readily, it makes it necessary to change them oftener.

DESIGN AND DETAILS OF CONSTRUCTION FOR CONCRETE CATTLE DIPPING VAT.

Profit of Dipping Vat. Farmers and stock raisers have long since passed the stage where they regard stock diseases as acts of Providence. They realize that most stock diseases are preventable and usually originate in some insanitary condition which might readily have been forestalled by proper sanitary measures. Without sanitary buildings and such improvements, it is impossible to keep all of the farm animals free from disease at all times. The dipping vat is really nothing but a wallow for animals larger than hogs. The Texas fever tick for example can be most effectively combated by dipping the animals in certain medicinal solutions. The simplest way to do this is to make them do the work themselves by forcing them to plunge into and swim through some kind of a vat containing the medicated solution. Properly constructed a concrete dipping vat is permanent and after built the only expense of treating stock is the expense of necessary solutions.

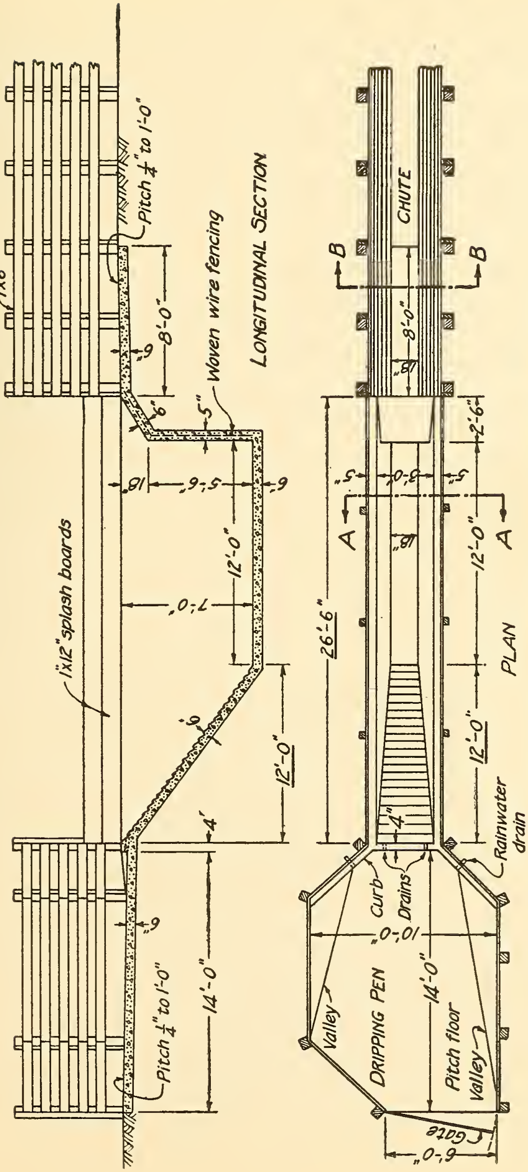
Requirements. There are a number of important features which should be considered when building a dipping vat. The site selected for its location should be well drained and permit the use of sufficient area of ground so that the chute can be built with dipping pen and two additional pens for holding cattle prior to dipping and after dipping until they have dried sufficiently to be turned loose. Accompanying sketches show in detail principal features of a concrete dipping vat that is advocated by the U. S. Department of Agriculture and of which thousands have been built through various tick infested regions of the South.

Excavation. Excavation for this vat should be made to conform to its outside dimensions and shape. Inside dimensions of the vat are shown in the drawings. No outside forms will be needed if the earth is self-supporting. Surface of the ground should slope away from the vat, pens and chute in all directions. Any earth that



View of concrete dipping vat in use.

must be returned to where excavated, should not be replaced until after the concrete walls of the vat have thoroughly hardened. Two 1½-inch drain pipes should be provided in the 4-inch coping between the vat and the dripping pen to permit drippings of the solution to flow back into the vat. Two similar drains should be

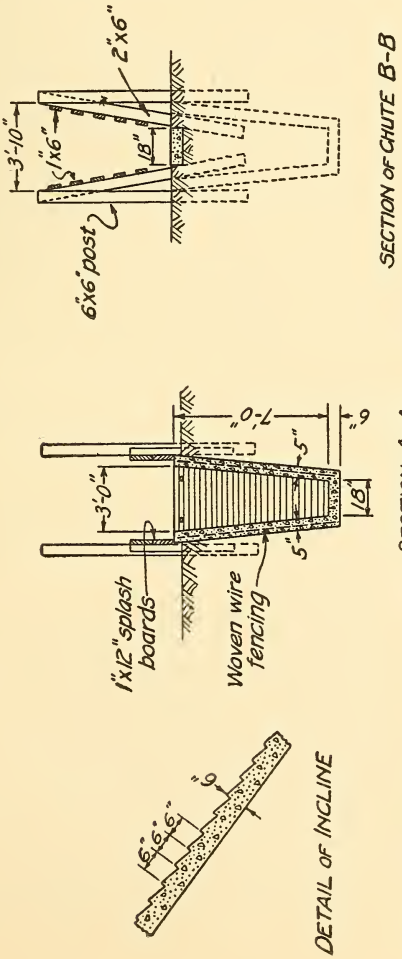


Longitudinal section and plan of concrete cattle dipping vat.

provided in a curbing at the lower end of the pen to permit rainwater to drain off to the outside of the pen. When the vat is in use these two drains should be plugged. One side of the wall of the dipping vat should be provided with a 2-inch overflow pipe set in the wall at a point 6 feet above the bottom of the vat, the top of the pipe to be provided with a valve and connected to a suitable drain.

Construction Details. The specifications for concrete materials with respect to clean, well graded, properly proportioned and mixed materials should be observed in this as in any other concrete work. Forms should be built of 1-inch boards dressed on one side and two edges nailed to 2 by 4-inch studs placed about 24 inches on centers. They should be substantial, unyielding and so built that they will conform to the dimensions and contour of the vat and should also be as tight as possible to prevent leakage of mortar while placing concrete. If 2-inch planks are used as sheathing the studs may be placed 3 feet on centers. In case the soil is not firm enough to stand up after the excavation has been made, exterior forms similar to the inner ones should be used, extending from the top to the bottom of the vat. After the reinforcement has been set in place the side and end wall forms should be lowered into the excavation and supported on the bottom by several pieces of small stone or concrete block about 6 inches thick. This blocking will permit the concrete for the floor to flow under the forms to the required depth of 6 inches. In order to place and spade the concrete properly it is desirable to nail the lower 3 feet of boards to the studding before lowering the form into position. Stay lath should be nailed to the studding at convenient places in order to hold the upper ends of studs in proper position. The remaining boards which make up the form and which

have been previously cut to the required lengths should be placed in position successively as described later. Reinforcement should be completely erected in place and fastened to the forms at convenient intervals so that it will retain its shape and position while concrete is being deposited. The forms for the walls should remain in



Details of incline and sections of cattle dipping vat and entrance chute to vat.

place until they may be safely removed as will be mentioned later.

Concrete should be mixed 1:2½:4, remembering that enough water should be used to produce a quaky consistency. The concrete should be placed in such a manner as to permit the most thorough compacting or settling into all recesses of the forms. This may be done by having only about 3 feet of form boards in place at the bottom of the forms and depositing concrete in layers of 6 to 8 inches. When the concrete has been brought up to a height of 3 feet, two or three more sheathing boards may be placed in position and nailed to the studding; and so on. The concrete should be placed in continuous horizontal layers and vertical joints should be avoided wherever possible. The exit incline may be built by embedding a piece of 2 by 4 lumber in the concrete or by building steps as shown on the drawing.

Concrete for the floor of the dripping pen, vat and chute should be deposited to the depth of 6 inches. It should be struck off with a strikeboard at the required point and finished with a wood float to leave an even yet gritty texture to the surface. All concrete must be protected for several days by covering or wetting, preferably both, so as to keep it from drying out.

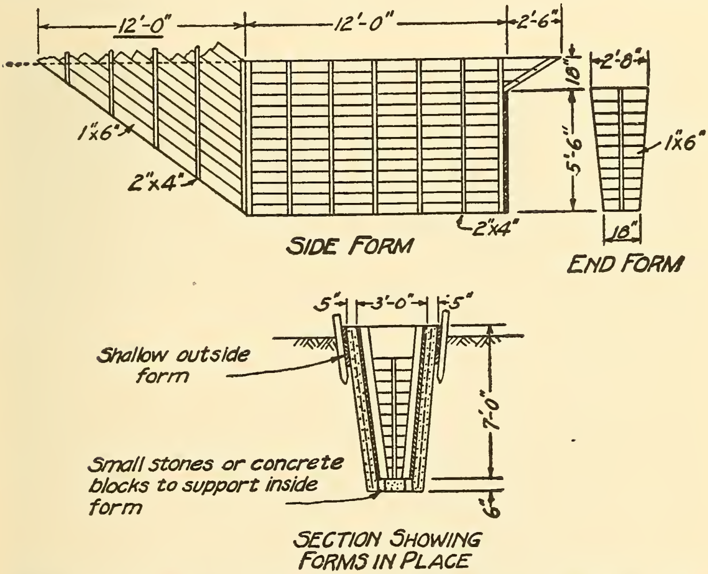
If the vat is built in a soil that is self-supporting wall forms may be removed after 48 hours. If the soil is not self-supporting they may be removed after 48 hours but the back filling should not be done for at least three or four weeks after the forms have been taken down and the vat should not be filled for at least five weeks after form removal.

For ordinary cattle, dipping vats should be about 5 feet wide at the top and 3 feet at the bottom, and from 7 to 7½ feet deep at the entrance end. The length

should be about 50 feet for cattle, as this will make certain of keeping them in the tank for at least one minute.

Sheep and hogs require a smaller vat, say about 3 feet wide at the top, 2 feet at the bottom, with a maximum depth of 5 feet 6 inches at the entrance end, and a length from 30 to 40 feet.

As concrete will not rot, rust or otherwise deteriorate, the construction is permanent. The economy of such



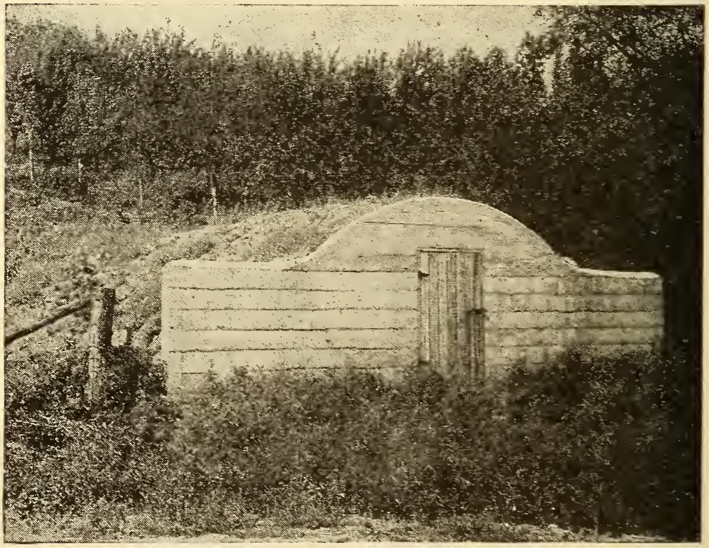
Details of forms for concrete cattle dipping vat illustrating also the method of setting forms in excavation.

construction can be proved in almost a minute. One need lose but a single high priced animal to have lost more money than the most elaborate dipping vat would cost. This proves that prevention is not only better than cure but usually far cheaper.

The only care that concrete dipping vates require is to have them enclosed so that persons or animals cannot accidentally fall into them.

STORAGE CELLAR FOR FRUIT OR VEGETABLES.

Every farm needs facilities for storing such crops as beets, potatoes, apples and similar produce which may easily be kept throughout the winter either for stock feeding or domestic use, in a proper storage cellar. In

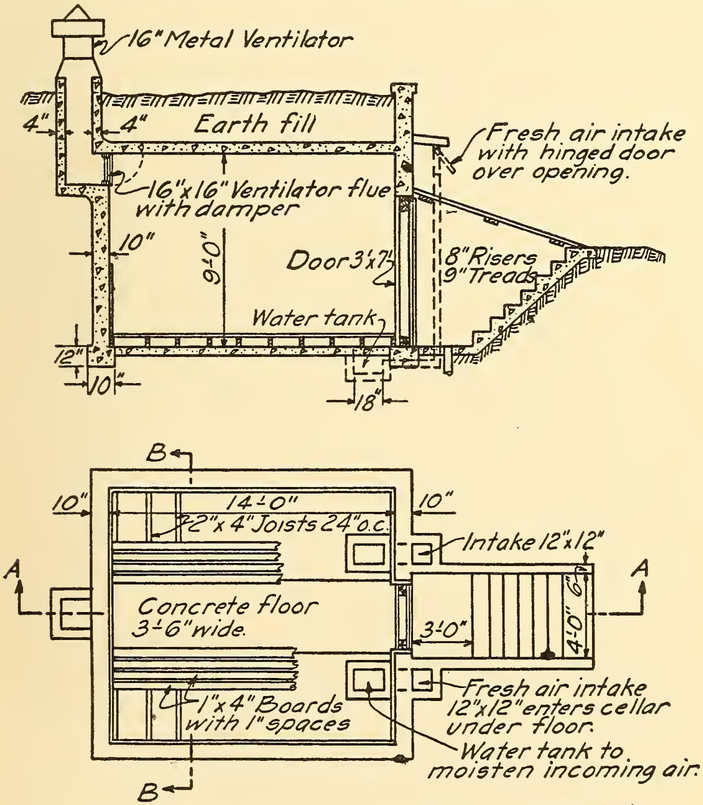


Concrete root or vegetable storage cellar.

some cases suitable storage facilities may be arranged in the cellar or basement of one of the outbuildings. Often, however, these are built without cellars and the logical solution of the storage cellar problem is to build a structure exclusively for the purpose.

The modern root or vegetable storage cellar is an extension of the old practice of digging a hole in the

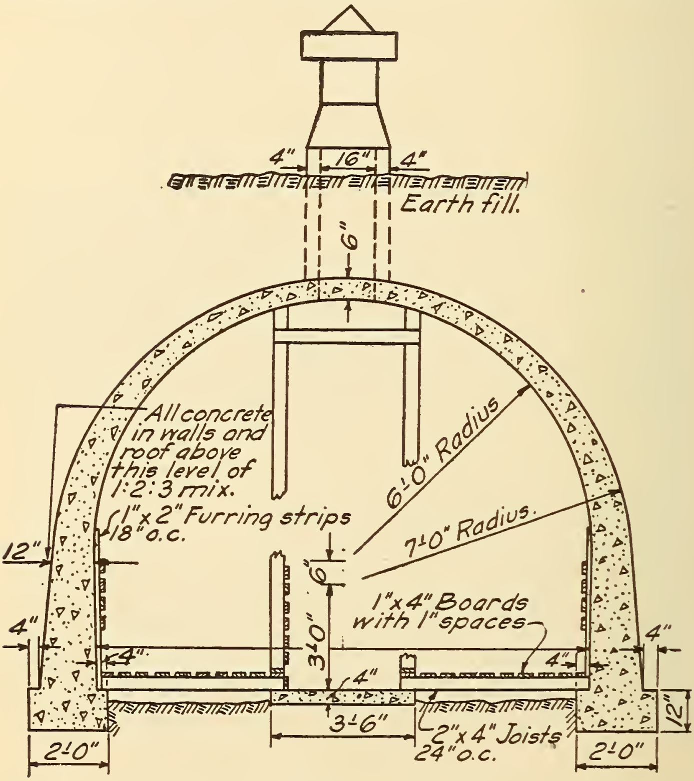
ground, covering the crop to be stored with hay or straw, and then covering the whole pile with earth, leaving some kind of vent or opening in the top of the mound for ventilation. Such method of handling any large quantity of crops involves of course considerable



Longitudinal section and plan of rectangular concrete fruit or vegetable storage cellar.

labor which is lost. Where the necessity for storing crops like those mentioned occurs annually a suitable storage cellar will soon return its cost and make it easy to get at the contents whenever and as often as desired,

and will permit the economical handling of a larger quantity of produce as well as enable the farmer to hold and market it at a most favorable season rather than force him to put it on the market at a time when every-



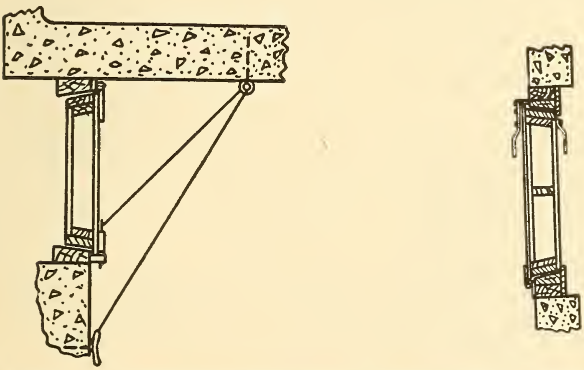
Cross section of fruit or vegetable storage cellar having arched top. No reinforcement is needed in this particular design because of the form of the structure. Concrete is so disposed of that it carries nothing but loads of compression.

one is doing the same thing and prices are therefore less attractive.

Some Construction Requirements. Since for best results the structure must be practically an underground

one, there are a number of important requirements to be observed. In many localities timber is available and seems at first glance the best material to use. But everyone knows that regardless of the kind of timber used for underground construction the fact that it is constantly in contact with moist earth causes rapid decay and necessitates rebuilding after a few years, to say nothing of the continual labor required to maintain it during its lifetime in condition fit for use.

Designs for Storage Cellars. Not every farm has the same needs with respect to storage requirements. It is

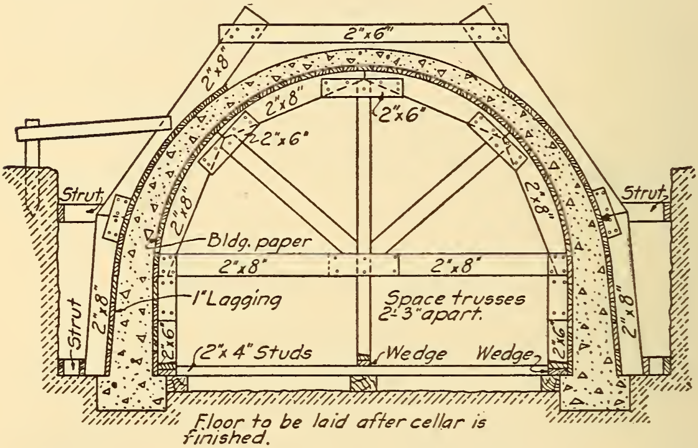


Methods of hanging ventilators and door on fruit or vegetable storage cellar.

therefore practically impossible to offer a design that will meet all individual needs without some modification. Accompanying drawings show types of storage cellars that may be expanded in capacity by the addition of units equal to the original structure, thereby providing required additional space.

Location. A storage cellar should preferably be located at one side of a knoll or hillside so that a portion of the structure at least can be set in the ground and the remainder of the exposed wall surface and the roof be easily banked and covered with earth. In the latter

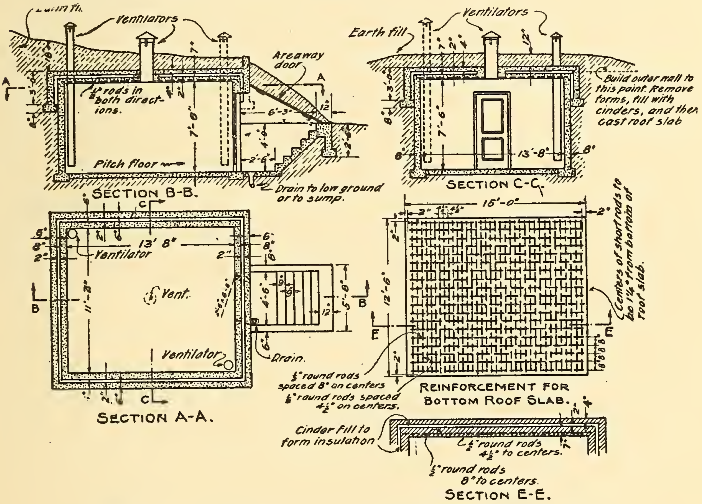
case 2 feet of covering should be the extreme amount applied to a flat roof. More is not necessary and might not be safe. Where the ground is level and the structure cannot be located on a knoll or hillside, it then becomes necessary to dig deeper and place a greater portion of the structure under ground. This will necessitate steps for entrance to outside and exit from the cellar and will not make the structure so convenient as regards the labor of filling and emptying.



Section through fruit or vegetable storage cellar, having arched roof showing details of forms necessary for its construction.

Reinforcement and Concrete Work. Reinforcement is shown for the structures suggested. This should need no further explanation. It is important that concrete be properly proportioned, mixed and placed so the cellar will be watertight. One important detail of storage cellar construction is that a suitable system of ventilation be installed to maintain proper atmospheric conditions and to prevent excessive dampness in the cellar due to condensation of moisture. There are occasions and conditions of construction where it is quite advisable to

build cellars like this of hollow concrete block or to veneer the inside wall surface of monolithic construction with hollow block or tile so as to introduce a dead-air space similar to that which would be used in icehouse construction to better insulate the wall, thus combatting the influence of outside temperature changes, in other words, making it possible to insulate the interior from the exterior and easier to maintain the required average temperature inside the cellar.



Design for concrete root or vegetable storage cellar.

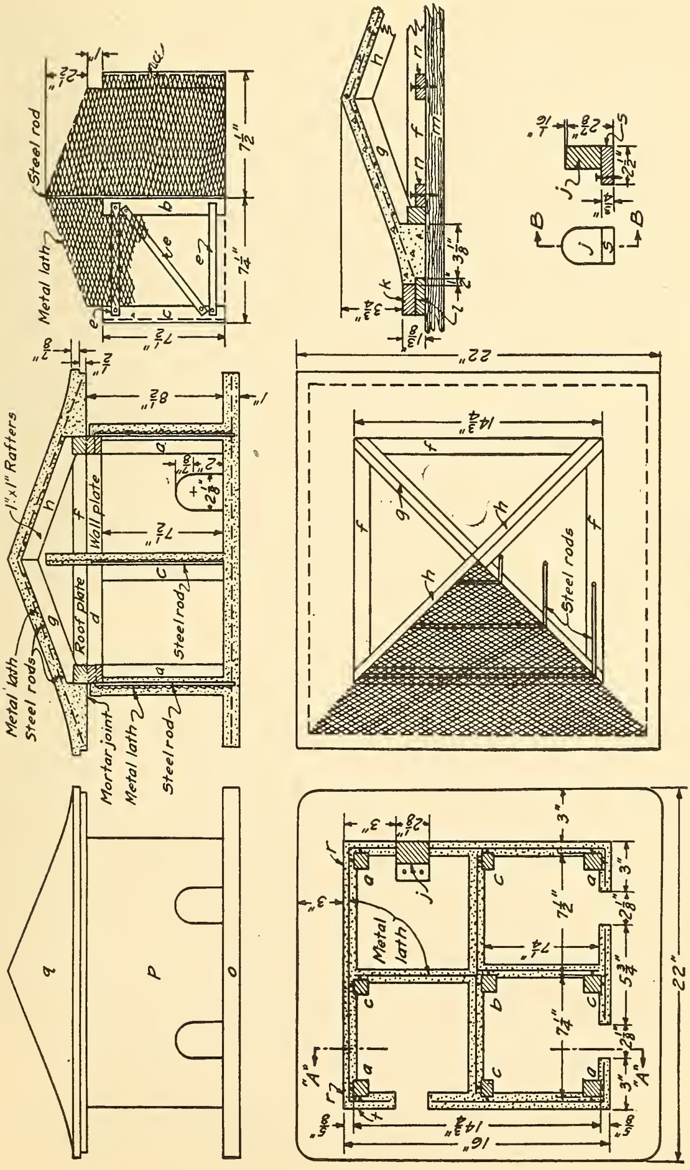
As will be noted from the plans the designs have been prepared with special reference to ventilation. During cool evenings manhole and cold air intake covers are removed and the cold air permitted to pass down into the cellar, circulating in the passage between the concrete floor and the false floor of the bins, these being made of 2 by 4-inch joists covered by 1 by 4-inch boards nailed 1 inch apart. These openings in the board floor and bin sides allow the air to pass up through the stored contents, thus cooling them.

PLANS FOR FOUR-ROOM STUCCO BIRDHOUSE FOR MARTINS.

An accompanying drawing shows various details of a cement stucco birdhouse for martins. This house rests on a concrete floor or platform 22 inches square. The birdhouse itself consists of four rooms, making a structure 16 inches square. The various parts are the platform or floor, outer walls, roof and partitions. The platform, or floor, is built of a square piece of metal lath or expanded metal stuccoed, that is, plastered on both sides with cement mortar to a total thickness of 1 inch.

Four holes should be arranged for in this platform by inserting greased wood plugs into the mortar and through the metal lath while the plaster is soft, to receive the rods (r) at the corners of the house.

The outer walls are formed by first nailing together the wood uprights (a) and wall plates (d). These are shown in the plan at the lower left-hand side of the illustration and in the section at the upper center. These rods are stapled to the sides of the corner posts (a) as shown. Intermediate or side posts (c) and the center post (b) may be difficult to hold in proper position unless temporarily secured by means of stay laths (e) as shown in a portion of the partition in the upper right-hand sketch. After metal lath or expanded metal has been fastened to posts (c) and (d), the temporary stays (e) may be removed. Metal lath or expanded metal, which is the ground work of the partitions, is first cut to the desired size so that the upper edge when set up will be slightly below the roof. The outer walls are then set on the platform so that the four projecting rods (r) will be



Design for stucco birdhouse.

embedded in the holes previously provided for them. This prevents side movement of the frame while applying the cement mortar or stucco. Partition walls are placed inside the outer wall and the posts (c) nailed to wall plates (d). The exterior walls and partitions should then be plastered with cement stucco. Before applying the plaster to the exterior walls, small cores, such as shown in the sketch at the lower right-hand of the drawing, should be set in cut-outs previously made to provide entranceways to the various rooms.

The roof is composed of roof plate (f) shown in the plan at the lower center of the drawing, and the hip rafters (g) and (h). After the rafters have been framed, they should be nailed together at the peak, and to the roof plate. Metal rods are then fastened to the upper surface of the rafters, as shown, following which metal lath or expanded metal cut to triangular shape is attached to the rods and rafters.

Various details of preparation for plastering the roof are shown in the center sketch at the extreme right-hand portion of the drawing. Cement mortar is troweled into the metal lath or mesh. After the stucco has become thoroughly hard, the roof section is placed on top of the wall plates as shown and fastened to them either with clamps or wood screws, but first there is placed a bed of mortar at the top of the concrete surface and level with the top of wall plates. The walls are then set in a bed of mortar on the platform and the four rods (r) grouted into holes provided for them, that is, the rods are permanently set in these holes by pouring around the rods a thin cream-like mixture of cement and water.

This plan may be enlarged or otherwise modified without in any particular respect changing the essentials of

the design. Any kind of metal fabric or expanded metal may be used. Other sizes of posts, rafters and wall plates may be substituted for the size shown.

Proportions and shapes of birdhouses may vary, but the same principles of construction when concrete or stucco is used apply to all types.

Each birdhouse must be planned to meet the particular habits and characteristics of the species of bird for which it is intended.

WATERTIGHT BASEMENT CONSTRUCTION

So much trouble has been caused from damp or leaky basements in which concrete has been used wholly or in part for foundations and floors that interest in the subject seems almost unending from the standpoint of how to remedy this undesirable situation. As is to be expected, most of the trouble occurs or becomes evident when it is not so easy to remedy as it would have been to prevent it by observing all requirements of concrete construction when doing the work.

It is very difficult to prevent leakage through masonry construction on account of the numerous mortar joints and the fact that stones or bricks are rarely or never so uniformly and thoroughly embedded in mortar as to prevent openings in the joints or courses. When concrete walls and floors leak, however, it is usually because they have been built without proper consideration of the problem of watertightness which is so easy to combat with concrete, or with a wrong idea as to the possibilities in this respect. Due to improper proportioning and mixing of materials, concrete walls and floors as usually constructed are often porous and when seepage of water occurs through them a remedy is attempted by applying some waterproofing treatment. In some instances basement floors and the lower portion of the walls are built below the normal level of ground water. This does not mean that normal ground water level is always above floor level but rather that during protracted periods of rainfall normal ground water level rises and stays for a time above its average level.

When the water level in the ground is above the basement floor a pressure equal to the head obtained by the difference in level of water and the basement floor will be expected. This pressure is greater than most persons realize even for a static head of only 2 or 3 feet. One cubic foot of water weighs 62½ pounds. If the cellar or basement floor is 2 feet below water level there will be thus brought to bear upon it a pressure of 125 pounds for every square foot of floor area. If this pressure fails to lift the floor and the concrete is porous, pressure is relieved by water passing through the concrete and eventually there is a standing level of 2 feet of water in the cellar. This is an unusual condition, of course, but serves as an illustration and even though the standing level may be only 2 or 3 inches, providing it remains it is difficult to combat.

One thing should be remembered by everyone doing concrete construction before he resorts to the use of any so-called waterproofing compound or medium and that is, there are many concrete structures in existence today in which only good concrete practice was used to secure watertightness for the various conditions to which they are subjected. This should lead one to realize that it is impossible to produce watertight concrete by merely following the best concrete practice. Many structures stand today a witness to the truth of this statement. Where leakage occurs in any of them it will be noticed that this is localized. It occurs either in spots or along well defined seams or lines which undoubtedly indicate that one or more batches of improperly proportioned or improperly placed concrete were deposited at various points in the work so that where the concreting of one day followed that of another, proper precautions were not taken to produce a watertight connection between the two days' work.

The only proceeding necessary to obtain watertight concrete is to select good materials as aggregates and to proportion them in such a manner as to obtain maximum density, using enough cement to form a sand cement mortar free from voids that will overfill the voids in the coarse aggregates. The consistency of the mixture should be wet enough so that it will have to be spaded in the forms rather than tamped. This will cause the concrete to settle to maximum compactness. The mixture should be especially well spaded against form faces so as to force back the coarse particles, thus avoiding aggregate pockets on the surface and causing a sand cement mortar film to lie against the form faces.

A good many of these principles have been briefly touched upon in other sections of this book but because of their importance it has been thought best to dwell upon them at greater length in this section, bringing all the points to be observed together in one discussion.

As a precaution over certain conditions in cellar foundation work, for example, it may be desirable to use bituminous or similar coatings, even on new work as a protection where cracks may occur due to settling of foundation or expansion and contraction caused by temperature changes. In larger exposed work it is practically impossible to prevent some cracks and the bituminous membrane will take care of leakage at these points if cracks occur.

Asphalt and coal tar are used for waterproofing by being spread on between several layers of burlap thoroughly impregnated with one or the other of the two materials. In other words, the bituminous membrane is built up in place in successive layers. To be most effective it should of course be applied on the outside wall face against which pressure of water first comes in contact.

FINISH OF CONCRETE SURFACES

Variety of Finish Possible. In addition to the ease with which concrete may be adapted to building almost any structure, is the advantage which the material possesses in permitting manipulations when placing or after placed so that the surface finish can be given a wide range of variety.

How Obtained. The various surface finishes which are given to concrete may be obtained by applying a cement water wash, floating the surface with wood or stone float after forms are removed, using selected aggregates on the surface when placing the concrete, tooling the surface, polishing it, using colored pigments in the mixture, cutting it in various ways to imitate stone cutting, and manipulating mortar coats in various ways so as to produce a stippled, pebbled or sand grained surface.

Leaving Concrete as it Comes From Forms. The simplest surface finish concrete can have is that resulting merely from placing it in well built smooth faced forms. In large masses, however, the appearance of such a surface is rather monotonous. Of course the monotony can be relieved somewhat by arranging for raised or depressed panels in the surface when the forms are built. This, however, does not come within the strict meaning of surface finish. The only color the natural concrete surface has is obtained entirely from the cement. The aggregate particles are covered with a film of cement and whatever color these may have does not show on the finished surface as produced only by contact with the forms.

It may be necessary in the case of such a surface to patch up small spots or imperfections due to not having everywhere forced back the coarse aggregate from the form face. Holes or stone pockets of this kind should be brushed out with a stiff wire brush and thoroughly washed, then pointed up with a cement mortar consisting of one part cement to as many parts of sand as were used in the concrete mixture; for instance, if the whole mass was a 1:2½:4 concrete, then the patching mortar used should be a 1:2½ mortar. Only in this way can patches be made to approach in color the remainder of the concrete surface. After patching, the areas thus treated should be gone over with a wood float and rubbed smooth. If the whole surface of the concrete is gone over in this manner as described later, a fairly uniform finish can be secured at little labor and expense. Dressed lumber will produce a smooth finish if forms are tightly joined so that the sand cement mortar cannot flow into joints, thus molding ridges like fins or seams on the concrete surface. Where concrete finish is to be left as coming from the forms, metal or metal-lined forms will naturally produce the best surface.

Painting With Cement Wash. Another method of finishing a concrete surface is to apply a cement wash. This consists of painting the concrete with a paint formed of 1 part cement, 1 part fine sand and enough water to make the proper consistency for painting on. The mixture must be kept thoroughly stirred while applied and it must be applied immediately after forms are removed. If the concrete has dried out such a paint will probably not adhere uniformly unless the whole surface to be painted is gone over first by vigorous washing with a stiff brush and clean water, or possibly with a weak solution of muriatic acid to remove the film of cement from the aggregates. After using

the acid solution, it is necessary to immediately wash down the surface to prevent further action of the acid; otherwise, aggregate particles would be loosened. However, the cement wash, no matter how carefully applied, is likely to check and hair crack. For this reason it is not reliable and is recommended for use only in finishing the interior of silos as mentioned under the section referring to those structures.

Rubbed Surface. Sometimes the concrete surface is ground down, so to speak, by floating with a carborundum stone. These are coarse grained, grinding stones that come in blocks about the size of an ordinary brick. To make it easier to operate this float or stone, the surface is thoroughly wet and sometimes a "lubricant" in the form of a cement sand paint such as described in the preceding paragraph is painted on and rubbed in. To float a surface in this manner the work must be done before the concrete has attained much hardness, so forms must be removed just as soon as the concrete is strong enough to be self-supporting. Ridges caused by joints in forms are carefully chipped off, the concrete surface thoroughly wet and rubbed with carborundum stone as described. A wood float can be used in the same way, but is effective only when the concrete is rather soft. The earlier the surface is rubbed after form removal, the better will be results by this method. Rubbing removes most of the inequalities, fills small pockets and cavities, and helps to give the surface a uniform finish and color. The results are superior to attempting to apply the cement water wash and the treatment is proof against the pitting, scaling and hair-cracking that is likely to result from the former method.

Surface Finish From Selected Aggregates. There is no question but that the most attractive surface finish that can be given to concrete is some one of many which

are in part prearranged in either mixing or placing the material. For example, colored sands and selected aggregates such as marble chips, granite screenings, slag, etc., are often used in place of the ordinary aggregates, in a facing mixture which is placed against forms and the ordinary concrete mixture placed back of this face. In such methods aggregates are selected principally because of the natural color they have or the color effects that can be produced by combining several aggregates of different colors. Feldspar, garnet sand and similar rock materials are also among the selected aggregates frequently so used.

Mixtures are prepared and placed in the usual way. When the concrete has hardened so that forms may safely be removed, the surface to be treated is gone over in one of the several ways to expose the surfaces of these colored aggregates and thus bring out their color.

When using selected aggregates for surface finish a limited amount of experimenting with materials available will always prove profitable. The color and texture of the finished surface depends upon the color and size of the aggregates used, and the successful production of the desired surface is dependent upon the proper selection, grading, proportioning, mixing and placing of materials as well as the actual finishing of the surfaces.

Washing Off Film of Cement to Expose Aggregates. If forms are removed within 24 hours after placing concrete, usually the surface film of cement covering the aggregate particles may be removed by scrubbing with a stiff brush and water. After the concrete has hardened so much that scrubbing with a brush and water will not remove this film, then an acid wash must be applied. One part of hydrochloric acid (commercial muriatic acid) is dissolved in 3 parts of water and applied to the

surface being treated with a paint brush, followed by light scrubbing with a bristle brush until the film of cement is removed. The work must be carefully watched so that acid action does not progress too far and as previously mentioned cause loosening of the aggregate. For this reason plenty of clean water must be at hand to immediately drench the surface being washed so that action of the acid may immediately be stopped. The entire surface must also be thoroughly washed to remove any trace of acid and its continued action.

Concrete block, architectural stone and similar products cast in molds are usually given a surface finish by laying the concrete mixture in a thin layer at the bottom of the mold and finishing the product with the usual concrete mixture. For vertical wall faces of monolithic construction the special facing mixture is placed in the forms just ahead of the backing which is placed against and rammed into it. Sometimes the facing material on vertical surfaces is held in place by a metal septum which is nothing but a sheet of steel 8 or 10 inches wide and 6 feet long with handles and angle iron riveted to the plate so it can be conveniently raised as the backing mixture is placed up to the level of the facing mixture. The angle irons are placed against the form to block the septum out from form faces the required thickness of the facing mixture.

Variations in color and texture of the surface which are to be secured by washing or otherwise exposing the aggregate, can be made almost without number by combining two or more selected aggregates. For instance, yellow or white marble chips, gray granite screenings and black crushed slag with a little micaspar or mica, are examples of possible variations or combinations that may be tried out to vary surface texture and color. Such

mixtures produce a surface having lively sparkle and variety.

Using White Cement and Special Aggregates. So far there has been no mention made in this book of what is known as white portland cement. This to all intents and purposes is like ordinary portland cement except in color and price. It is white principally because the raw materials used in its manufacture are free from some of the mineral impurities contained in raw materials used in ordinary portland cement. It is non-staining and is used very extensively in ornamental objects, such as flower boxes, lawn seats and other garden ornaments where a surface more nearly resembling certain classes of stone texture is desired. By combining white portland cement with crushed granite as aggregate and then washing the concrete to expose the aggregate, a finished surface that frequently cannot be detected from natural granite is produced.

Cutting or Tooling. Concrete surfaces are sometimes tooled in one of several ways similar to the methods used in cutting or tooling ordinary stone. If it is the intention to finish the surface by some one of the tooling methods, great care should be taken to select the aggregates and still greater attention given to proportioning the concrete mixture so that it will be certain that the aggregates are of uniform hardness throughout and that the concrete mixture is just as dense with aggregate as possible to make it; in other words, there must be a minimum of cement surface when tooled; but, if the mixture contains too little cement there will not be enough bonding or binding material in the mass to prevent the small particles of aggregate from being dislodged or broken out when the surface is tooled. The concrete surface that is to be tooled must have attained

greater hardness than necessary for manipulations under the methods of surface treatment previously described. It must have attained an almost flint-like hardness so that aggregate particles will not be broken out of the surface under the action of tooling or cutting. It is the particles of aggregate themselves that must be tooled or broken on the surface to give the desired effect of cutting. Objects that have been steam hardened first are even better for tooled finishes.

The concrete surface may be tooled by using stone cutters' chisels, just as marble and other stone are cut. The usual tooling is done by hammering with a bush or pean hammer such as used by stone dressers. Under repeated blows from such a hammer the aggregates are slightly cut, thus disclosing their color and giving the required cut stone appearance to the concrete surface. As in other tooling methods it is important that the aggregates in a concrete that is to be surface finished by pean hammering be of uniform hardness so that all stones will be cut instead of a few cut and some chipped out of the surface. Broken stone aggregate is better than pebble aggregate for tooled finishes.

Polishing Concrete. Concrete surfaces may be given a polish similar to that obtained on granites and marbles but the degree of polish secured depends upon the susceptibility of the aggregates to receive polish and the percentage of aggregates that lie on the surface to be polished. Examples of such finish are seen in so-called mosaic or terrazzo floors. The nearest approach possible to 85 per cent of aggregate surface should be aimed at when mixing the concrete.

Adding Coloring Matter. Another variation possible in concrete surface comes from adding coloring matter to the cement. This practice also can be combined with

that of selecting aggregates. For example, if a uniform reddish tone is desired as a surface finish then coloring matter such as red oxide of iron may be added to the cement, and pink granite chips used as aggregate. The surface is treated by washing and scrubbing with acid solution, or if it has not reached too great a degree of hardness, by rubbing with carborundum stone, as already described.

Coloring by Immersion in Dye.* Another way of varying the color of concrete surfaces as relates however only to small objects, is to immerse them in some solution that will dye or stain the surface. The importance of thoroughly mixing coloring pigment with the cement before adding the aggregate must be appreciated by anyone attempting to make concrete in colors by the immersion method. If the object being made must have a certain maximum strength, it should not be placed in the coloring bath until the concrete has thoroughly hardened, because filling the pores with the coloring matter in solution stops the chemical action or changes taking place in the cement leading to hardening of the concrete.

Coloring by absorption is effective on surfaces of concrete after it comes out of the mold or after being treated with acid or tools. Surfaces treated by color absorption, providing the coloring matter is from mineral pigment, are less absorbent and the action of the weather on the metallic colors is the same as on real metals. It increases the beauty of coloring by the usual oxidation noticed on bronze and copper. The surface of concrete treated by such methods becomes so hard and dense that it will take a uniformly dull or high gloss polish. Many admired pieces of pottery displayed in art stores are nothing but concrete treated in this way. Flower boxes, vases and similar ornaments thus manip-

* From "Concrete," Detroit.

ulated are very attractive, the artistic possibilities of the treatment being limited only by the colored sand and the ingenuity displayed by the worker. Aniline colors and the sulphates of copper and iron are considered best adapted to the making of solutions to color concrete by this absorption method.

Pigments to Use. When an attempt is being made to secure a color effect partly by using mixing colors with the cement used in a batch of concrete, it is important that only reliable pigment be used if permanent tints are expected. The cement, sand and coloring matter are mixed together dry and it is advisable to experiment a little to determine how much color will be required to give the desired shade. After water has been added to the mixture the mortar appears considerably darker than it will be when the final surface has hardened and dried out.

By mixing 5 pounds of coloring matter with a sack of cement the following colors are obtained:

Raw oxide of iron will give a bright red.

Roasted iron oxide will give brown.

Ultramarine will give a bright blue.

Yellow ochre will give buff or yellow.

Carbon black or lamp black will give dark gray or slate.

Equal parts of carbon black and red oxide ore give dull reds.

In all cases mineral colors added to the concrete mixture cause some loss of strength in the concrete. This, however, is not of great importance because where a coloring matter is used it is in general in connection with work where strength is not the most important requirement.

Sand Blast Surface. Concrete surfaces are sometimes finished by what is known as the sand blast method. This is probably not within the range of the average worker. No doubt most people have seen city buildings being cleaned by a stream of fine sand directed against the surface by air pressure. Constant striking and impinging of these particles against the surface under this air pressure removes by wear the cement film and gives the sand surface.

Surface Variety With Stucco. Other surface finishes are a particular feature where stucco is used. The simplest finish of stucco is that obtained by uniform troweling of the surface with a wood float. Too much troweling, especially where steel trowel is used, will cause the plaster to crack. The principal surfaces used in connection with stucco are rough cast, slap-dash and pebble-dash. These surfaces are distinctive of stucco, although stucco is sometimes finished with a plaster coat prepared especially for exposing aggregates in the mortar after one of the methods already described.

A rough cast finish to stucco can be obtained by going over the freshly plastered surface with a trowel covered with carpet or burlap. The work must be done before the mortar has begun to harden, and to provide for the best results the mortar of the last coat should contain a slight excess of sand and not be applied too wet.

Slap-dash finish is secured by throwing on the final coat with a wood paddle. This requires some little practice but after the knack has been acquired a very attractive surface can be produced in this manner.

Pebble-dash is obtained by throwing clean pebbles into the fresh water of the last coat before it has commenced to harden. Considerable variety is possible in

pebble-dash finish. Pebbles should be uniformly about ½-inch in greatest dimension, round and of good color. Variety is obtained by using different colors. The pebbles should be washed thoroughly and be wet when thrown against the mortar. Sometimes, however, it is not desired to expose the actual surface of the pebbles. Then they may be wet with a cement water paint immediately before thrown against the surface and if treated in this way are more certain to adhere firmly to the stucco.

RUBBLE CONCRETE

In many sections of the country farm land is littered with field stones lying on the ground or a few inches below it, materially interfering with the cultivating of what would otherwise be very productive farms. Some farms are often almost paved with such stones which serve as a handicap to all farming progress, while with well directed labor these can be made to vanish and a group of farm buildings obtained from the land. These stones more often than not make first class aggregates when properly crushed and screened to suitable size. In this way the land yields permanent structures that add to its value in two ways, first by making the soil itself more productive and by increasing the value of the farm as a whole through the permanent improvements built of concrete.

Nearly every farm today has its small gasoline engine, and if any number of buildings are to be built and no other concreting materials are available, it will pay to buy a small stone crusher, thus making an outfit that will convert these stones into building material. In some cases they can be used in building construction without breaking them up. They are then laid like other masonry and the finished work is known as rubble masonry. If the stones are used in concrete without crushing, then the work is called rubble concrete.

Quite attractive rubble masonry may be made by properly selecting and laying the field stones against the back face of concrete forms, and filling in between and behind stones with a suitable concrete mixture. When forms have been removed the exposed face of the stones

is cleaned off, the joints picked back or given added filling if necessary to make all joints of uniform depth from the face, and very attractive masonry effect results.

How to Lay Rubble Concrete. A general rule of concrete construction ordinarily limits the size of pebbles or broken stone that may be used in any concrete mixture to particles that do not exceed in greatest dimension ⅓ the thickness of the wall or other member of the construction in which employed. After conforming to this limitation the rubble stones or field stones must be properly proportioned with cement, sand and pebbles, to slightly overfill the air-spaces or voids existing among the field stones themselves.

As a rule it will be found more economical to break up the stones to small sizes corresponding to well graded pebbles or broken stone and use them in a concrete mixture, for experience has shown that rubble concrete for thin walls is not always as economical as might first appear. This is due in a large part to the extra labor required to handle and place the stones properly and the necessity of using a richer mortar than would be required in plain concrete construction. In addition to this such work requires that to secure the same strength of a thin wall made of concrete in the usual manner, the rubble wall must be made more massive, that is, a 6-inch concrete wall built in the regular way using cement, sand, and pebbles, the last graded up to 1½ inches, would cost less than the rubble wall which would have to be say 12 inches or more thick in order to properly dispose of the field stones and make certain that the resulting wall would be of strength equal to the 6-inch wall made of the usual concrete mixture.

Experience has proven that the best way to place rubble concrete is to first put in the forms a few inches of concrete mixed rather wet. A 1:2:4 mixture should

be used. Large, hard, clean field stones may then be laid in the concrete in the forms, then more concrete added, taking care that each field stone is completely surrounded by concrete, and so on. The large stones should not lie nearer to each other than 3 inches and the volume of such stones used in any construction should not exceed 33% of the total volume of the wall or section being built. Concrete must be mixed moderately wet. It is essential that all rubble stones be surrounded by concrete to prevent formation of pockets or air-spaces which would weaken the mass and prevent watertightness. Such pockets always result from carelessly dumping the stones into the concrete instead of distributing them about uniformly by hand as described. A layer of concrete from 1 to 2 inches thick should separate the field stones from the face of the walls.

Rubble work, especially rubble masonry, lends itself to so great a variety of application that the results are largely a matter of individual treatment. Exterior chimneys, porch balustrades, columns and gate posts can be made quite artistic of rubble concrete.

Using Rubble Stones in a Foundation. Foundations where the wall is not to be watertight but simply serve as a support for a building, may be quickly built by properly disposing of such stones in a trench and filling in with good concrete between and around different layers and individual stones.

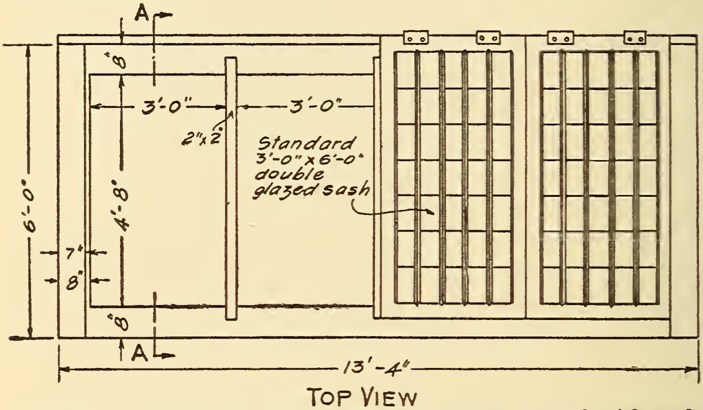
CONCRETE HOTBEDS AND COLD FRAMES.

An easy way to make the home garden last practically throughout the year is to have a hotbed. But the average hotbed is built of lumber which of necessity is in constant contact with the soil and as a result of alternate moist and dry conditions soon rots out. This compels rebuilding every two or three years at least. Building of concrete prevents this waste of labor and material. A concrete hotbed is not only useful for what it provides for the home table, but in early spring can be made a source of revenue by starting garden and flower plants for market. Tomatoes, cabbage, onions, peppers, cauliflower, sweet potatoes, radishes, head lettuce and a variety of other vegetables can satisfactorily and profitably be started in the hotbed.

Location. The hotbed should be located on some sunny slope or otherwise protected from wind. The standard hotbed sash is 3 by 6 feet. Usually a bed requiring 4 sashes to cover is large enough except for commercial purposes. For commercial needs any desired size may be obtained by increasing length. In some cases commercial hotbeds are so made that after they have served their early use as such, glasses and supporting frames can be taken off and a one horse plow operated between side walls so that the soil can be cropped throughout the season.

The hotbed should be 6 feet 6 inches wide and any required length. Center bars supporting the frame are of dressed 1-inch material shaped like an inverted T. The hotbed walls should be 6 inches thick. They should be carried down below possible frost penetration. As a rule it is not necessary to start the wall upon a footing

but because of the narrowness of the trench it is customary to excavate most of the enclosure so that concrete for walls can be conveniently placed. An outside form is not necessary except above ground if the earth is self-supporting. Inside forms can be roughly set up

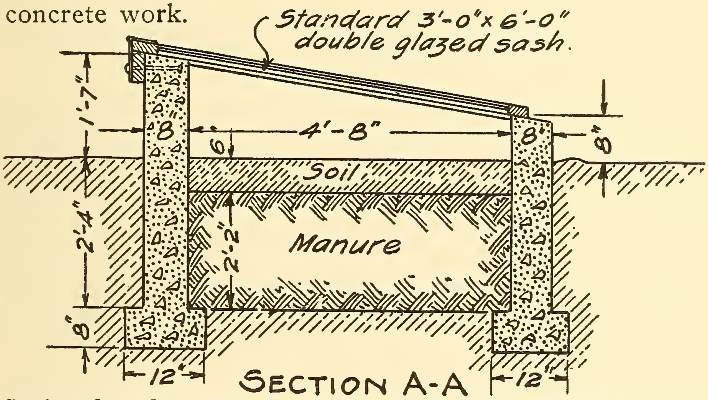


Top view of concrete hotbed showing bed partly covered with sash.

supported by stakes and braces. After forms have been set they should be checked to see that the dimensions of the bed are correct for the size sash to be used.

Concreting. Concrete should be mixed in proportions of 1:2½:4, enough water being used to form a quaky consistency. Grooves may be made in the top of the walls by temporarily embedding wood strips of necessary dimensions in the concrete to provide for bringing frames level with the top of the hotbed walls allowing ¼-inch at each end for clamps. Provision for the center bars or T strips to support the edges of the strip can be made by nailing blocks to the strips on the under side before placing in position. The strips should be tapered slightly to make withdrawal easy and they should be removed as soon as the concrete begins to harden. Forms can be removed as soon as concrete has hardened. During this time, however, concrete should be

protected by some kind of a covering to prevent rapid drying out as has been described in connection with other concrete work.



Section through concrete hotbed giving various dimensions and suggesting the manner of preparing the bed with manure and soil for operation.

The only difference between a hotbed and a cold frame is the manner in which it is to be used. If the bed is to be used as a cold frame the proper amount of soil is thrown back into the excavation when the form has been removed and the bed covered with glazed sash. To operate as a hotbed the excavation should be 2 feet deep measured from outside ground level, in which 18 inches of fresh horse manure should be packed, well mixed with leaves, and should then be covered with 4 to 6 inches of rich soil. Surplus soil from the excavation can be banked around the outside wall of the bed to help retain warmth generated in the interior. Put on a sash and place thermometer inside of the bed. The temperature will shortly begin to rise and the rise will soon be rapid. After reaching a certain maximum it will begin to fall. When the temperature has dropped to 85 or 90 degrees Fahrenheit seeds may safely be planted. The manipulation of the sash afterwards will depend entirely upon outside weather conditions, and how rapidly it is desired to force or how much to retard the growth of plants.

DESIGN FOR CONCRETE CISTERN WITH FILTER

Concrete Ideal for Cisterns. Sometimes cisterns are built wholly or in part above ground, yet the natural place for such a structure is below ground. A cistern is nothing more or less than a tank required to keep clean water in storage without loss from leakage. It is therefore necessary that the structure be watertight. Cisterns have been built of such masonry as brick and stone but this cannot be depended upon to be watertight unless plastered, since leakage is almost certain to take place through mortar joints. For that reason concrete construction is perhaps more adaptable to the requirements than other materials. Steel tanks have been used for cisterns but from the very nature of the material it is subject to rust and cannot be regarded nearly as permanent as concrete.

Shape and Forms. Since the advent of the commercial silo form used by rural concrete contractors in building concrete silos, many persons have had circular cisterns built. The home-made silo forms illustrated elsewhere in this book can be adapted to circular cistern construction if required, but unless one has already built such forms for use in constructing a silo, it is easier to build forms for a rectangular cistern.

In order to illustrate the principles of constructing a rectangular concrete cistern, the accompanying sketches have been fully detailed and show a cistern 7 feet square by 6 feet deep. A very advantageous detail of this cistern is the filter built on and as a part of the cistern cover slab. Rainwater enters this filter through the 6-inch

tile drain shown and goes into the settling compartment containing the screen. This screen helps to prevent refuse such as leaves and other rubbish from going immediately into the filter compartment and thus clogging the filter material. The approximate capacity of this cistern is 70 barrels.

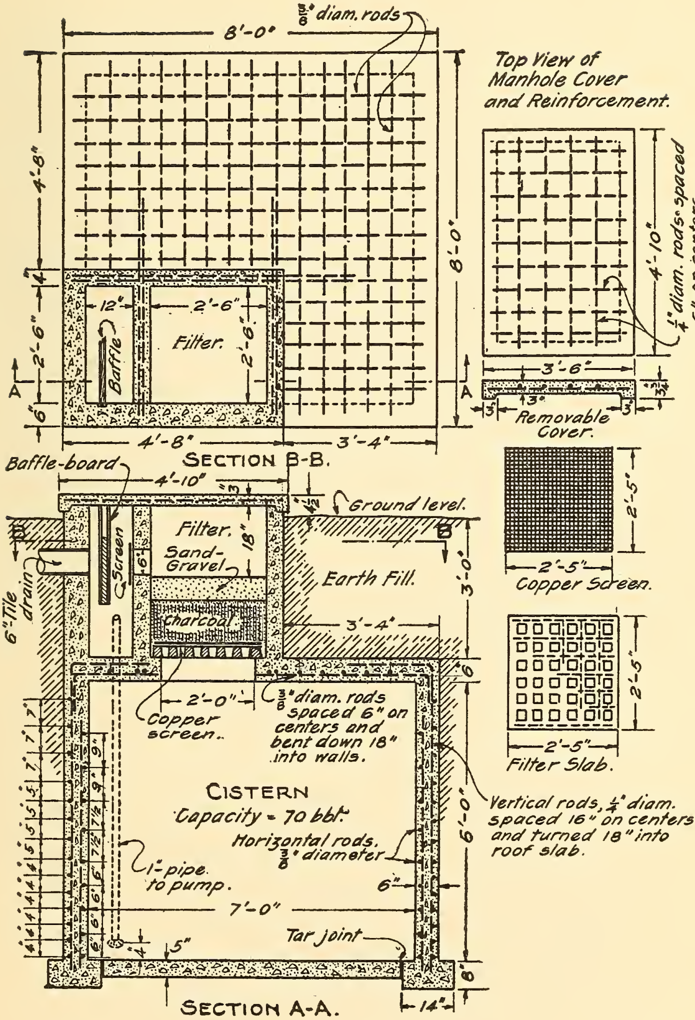
Materials Should All Be Ready Before Starting Work. Before commencing to build a concrete cistern all necessary materials should be on hand. It is always well to have a slight excess of materials over and above those required, to provide for slight loss due to waste in mixing and placing or to shortage through possible miscalculation of quantities required. The first thing to do is to lay out a square on the ground 8 feet on each side. If the earth is firm enough to serve as an outside form no other form will be needed. If, however, the earth has a tendency to cave, it will be necessary to make the excavation larger so that outside forms can be erected. As the concrete floor of the cistern is 5 inches thick the excavation should be made deep enough to allow for this and for the 3 feet of earth covering shown on the cistern roof. The cistern filter is 4 feet 8 inches by 3 feet 4 inches and covered with a reinforced concrete slab.

Forms. All necessary forms should be built before commencing the excavation so if a sudden shower comes up forms can be quickly placed to prevent the earth from caving if it becomes water soaked. One-inch boards 4 or 6 inches wide, nailed to 2 by 4 inch uprights or studs placed 2 feet apart will make suitable forms. It will be noticed that two sides of the filter compartment have 6-inch walls which correspond to the wall thickness of the cistern, thus simplifying form construction in carrying this part of the work up into the filter. One-inch boards 4 by 6 inches wide nailed to 2 by 4-inch uprights

or studs placed 2 feet apart will make suitable forms. The excavation as suggested should be made deep enough to provide for the small footing extension of the side walls, which extend below the floor slab. In this work it is expected that concrete for the side walls will be placed before the concrete floor is laid. Concreting of walls should be as continuous as possible to prevent construction seams or joints.

Reinforcement. Horizontal reinforcing consists of 3/8-inch round rods spaced 6 inches center to center. The spacing of reinforcement for the various depths inside and out is shown to the left of section A-A in the section of concrete wall. Vertical reinforcing for the side walls should consist of rods long enough to permit of ends being bent over into the concrete roof or cover slab when this is the case. A plan of reinforcing for the roof shows in position a section of filter walls and the spacing of reinforcing rods for the cover slab, these rods also being 3/8-inch in diameter. Other sketches show details of the copper filter screen, the concrete filter slab on which the screen is placed, the removable cover for the filter compartment and the reinforcement for this cover slab. Vertical reinforcement in the cistern walls consist of 1/4-inch round rods spaced 16 inches center to center and turned 18 inches into the roof slab.

Concreting. After the concrete has been placed for the side walls up to the bottom of cover slab the work may stop until the concrete has hardened sufficiently to permit removing forms, following which the concrete floor can be laid. A 1/2-inch beveled strip of siding should be set all around the bottom of wall at floor level against the offset of the footing and after the concrete floor has been placed and has hardened, these strips should be removed and the space left by them filled with hot tar to form a leak-proof joint. When the floor has



Detailed design for concrete cistern with water filter.

hardened, which will require several days, studs can be set up to support the form on which the roof or cover slab concrete is to be placed. A hole should be left in this form, located to correspond to the location of the manhole in the filter so that after the roof has been concreted, entrance can be obtained to the cistern for knocking down the studs and removing forms.

Wherever reinforcement crosses or intersects it should be tied together with small iron wire so that rods will be held in their proper position and will not be displaced. Concrete should be mixed not leaner than 1:2:3. It should be of quaky consistency so that it will settle to all parts of the form and around reinforcing with slight puddling. Make certain that the concrete is thoroughly puddled around the concrete bricks or blocks used to support the forms at the bottom, at the same time taking care not to cover up these so as to prevent removing them when taking down forms. Wedging up the forms in this way at the bottom by placing these wedges under the studs allows the form to be dropped slightly and released when time to remove it.

Concrete should be placed as continuously as possible in courses not exceeding 6 or 8 inches entirely around and in the space between forms and should be well spaded next to faces so as to force back the coarse materials in the concrete and bring a film of mortar against the forms, thus resulting in a dense, smooth and consequently impervious surface.

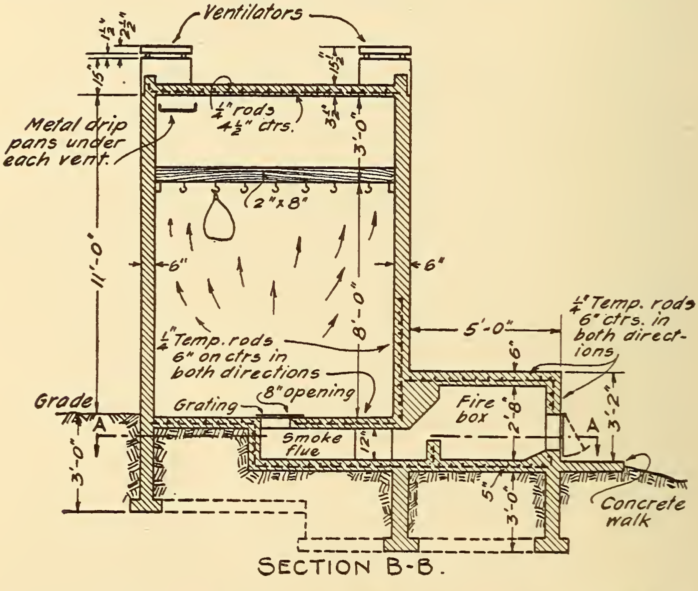
If outside forms are not required, use care when placing concrete so as not to knock down dirt into it. If this happens porous pockets will be formed and probably leaks will result. Continuous concreting is desirable because in this way all concrete will be placed against fresh concrete, that is not hardened, and thus leaky construction seems will be avoided.

If an overflow opening is desired, arrange this at the proper level and connect it to a suitable outlet. The inlet pipe from the house drains should be placed as much below ground as depth of the structure will permit so as to prevent freezing. Two weeks after the last concrete has been placed it should be safe under usual summer weather conditions to remove the cistern roof forms.

Material used in the filter compartment for filtering the water consists of a layer of granular charcoal about 18 inches deep, on top of which is a 6 or 8 inch layer of clean well graded sand and gravel. A screen of ¼-inch mesh copper wire is placed over the pipe opening into the cistern in what has been already referred to as the settling compartment. This screen is held in position by the baffleboards as shown. It would be well to thoroughly wash out the cistern before filling with water for the first time although this will not be necessary unless the water is to be used for domestic purposes other than laundry work.

DESIGN FOR CONCRETE SMOKEHOUSE

Practically all the meat in the country originates on our more than 6,000,000 farms, yet on the large majority of these there are no real provisions made for

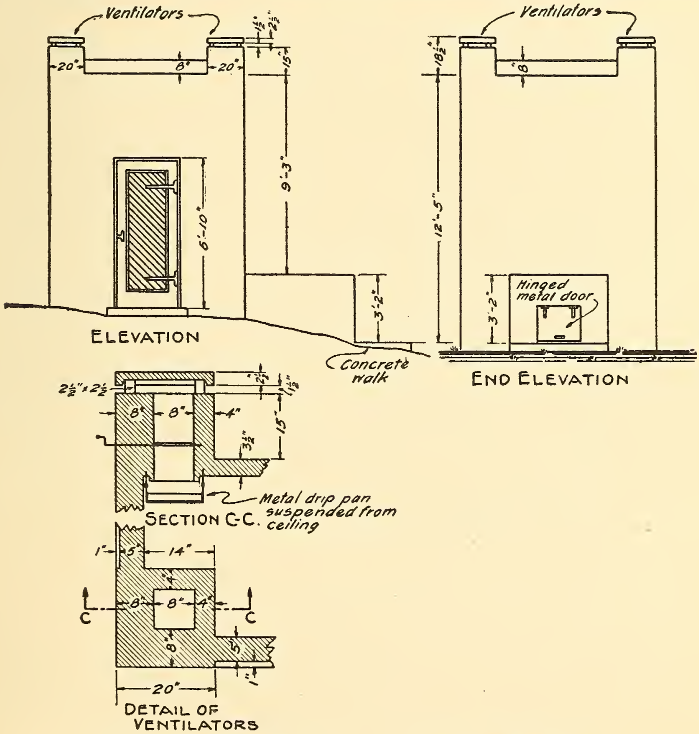


Section showing plans of smokehouse and firebox, also position of ventilators.

killing animals for home use or preserving meat in any way. This is an economic waste, for these farms all use meat and purchase it at a profit to someone else. Each farm, therefore, should have its own smokehouse where the meats may be prepared for use and preserved until needed. Curing by pickling and smoking has been practised for centuries. On the modern farm the work is considerably simplified by the erection of a concrete

smokehouse. Suggested plans for such a structure are shown herewith.

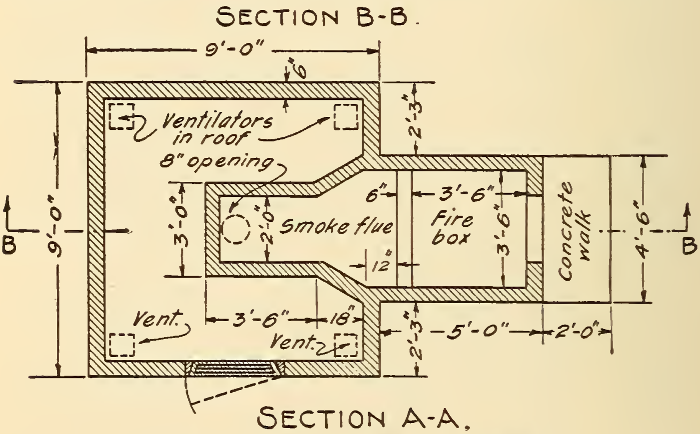
Type of Structure. The smokehouse may be either rectangular or circular. It is convenient to build the circular form where one has access to commercial silo



End and side elevations of concrete smokehouse.

forms or the home made silo forms illustrated elsewhere in this book may be adapted to circular smokehouse construction. Concrete is ideal for the smokehouse because it is fireproof, rat-proof and can be made theft-proof. Circular smokehouses are to be preferred as compared with square ones as the distribution of smoke is much better.

The fire box should be located entirely outside of the smokehouse proper to insure uniform smoke distribution and better regulation of the fire. Down draft into the flue leading to the center of the smokehouse reduces the draft somewhat, making a denser smoke, which is the desired result, and tends to deposit particles of ash which might be carried out of the firebox. As much care should be taken in building a smokehouse as is applied to any other reinforced concrete structure. In



Horizontal section of concrete smokehouse.

the firebox where exposure to heat will be greater, additional care must be taken to secure hard, tough, durable sand and pebbles for some materials such as limestone are apt to crumble under the continuous action of the heat. It would be better to line the fire box compartment with 1/8-inch sheet steel cut and formed to the required dimensions. This when in place will serve as the inside form for the firebox. Although concrete is fireproof it is not intended to be used where exposed to constant, and intense heat. Plenty of reinforcement should be used. The vertical rods in the side walls

should be long enough to be bent over into the roof slab about 12 or 18 inches. It is well to have a number of small ventilators so that one or more may be closed to reduce the draft and to properly distribute the smoke throughout the chamber regardless of the direction of the wind.

Dimensions of the house may vary somewhat for local conditions. It is preferable to hang meat at least 7 feet above the floor both to secure a more even smoking and to prevent too much heat from reaching it.

Block also may be used for building smokehouse walls, care being taken to fill all the joints so they will be leak-proof. In either case practically the same details should be observed although no reinforcing will be required when 8-inch block are used for walls. As the interior of a structure of this kind will be subjected to considerable heat, it is important that the concrete be at least thirty days old before fire is started. If this precaution is not observed, the concrete will dry out instead of harden properly, causing it to be soft and crumbly hence less durable.

TOOLS FOR CONCRETING.

One feature of concrete work that makes a strong appeal to the average user is the fact that no costly equipment in the way of tools need be purchased unless desired. That is, practically all of the tools actually needed can be picked up at home or be home made. Anything other than these are likely to be more in the nature of a convenience than a necessity.

The first tool needed is a screen over which gravel may be passed to separate sand and pebbles. This screen should be ¼ inch square mesh or of slotted wire mesh that will permit passing all particles ¼ inch or under. The screen may be built of 2 by 4 frame to which the mesh or netting is nailed and should have two legs hinged at one end to enable setting the screen at an angle of 45 degrees with the vertical when in use. Another screen may be needed of 1 or 1½-inch mesh so that the pebbles may be passed over this screen if there be any considerable number of larger particles to be excluded.

Square pointed shovels are needed for mixing.

A water barrel and pails for handling water are required.

A strikeboard, which may be any straight piece of lumber from one to two inches thick and from 4 to 6 inches wide, will be required to strike off the surface of concrete when laid in such work as floors or walks for example.

A wood hand float or trowel is needed for finishing concrete surfaces.

A hose is convenient if there is a supply of piped water.

A mixing platform made of tight 1 by 4 tongued and grooved boards nailed on two or three 2 by 4-inch studs is needed, depending upon the size of platform to be built. Strips should be nailed around three edges of this platform to prevent shoveling off material when turning in the process of mixing.

A steel plastering trowel may be needed for occasional use.

A measuring box which is nothing but a bottomless frame of one, two or four foot cubic capacity, is also required. If this is more than one cubic foot capacity, marks should be placed on the interior to indicate capacities at various levels.

A tamper made out of a piece of 6 by 6 or 8 by 8 timber 12 inches long with a round handle set in a hole bored in the block is another tool required.

Spading tools to agitate and settle concrete in the forms have been described under placing concrete.

A wheelbarrow is always convenient if concrete must be moved any distance after mixing.

A power operated mixer is very desirable if any quantity of concrete is to be mixed because it makes work easier.

Various kinds of small tools such as groovers and edgers intended for making joints where slabs adjoin and slightly curving edges of walks and outer margins of slabs are also convenient to have when laying floors and walks.

If any considerable quantity of reinforcement must be shaped, some one of the several varieties of bending devices may be required, but as a rule these are not necessary where reinforcement no larger than ⅜ or ½-inch rods are being used, as these can readily be bent to required shape around and over improvised blocking fixed on firm wood platforms rigidly supported.

CONCRETE CULVERTS

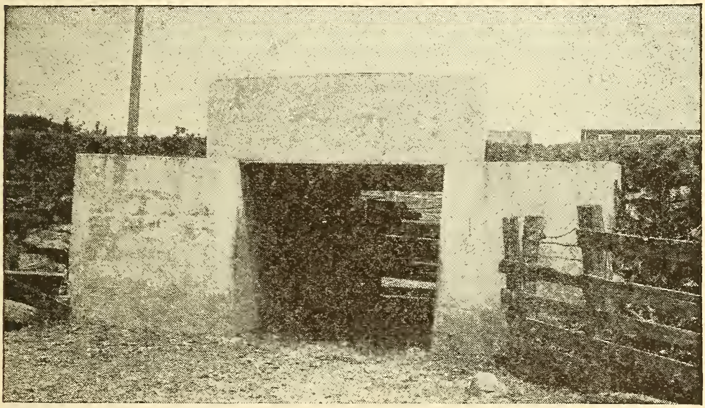
When Culverts Are Needed on the Farm. Many farms are crossed by a creek or small stream that divides the farm so that it is necessary to provide crossings of the stream at various points that farm implements may be taken from one field or part of a farm to another. In the past the farm bridge across the small stream has usually been two stringers with planks laid over them—a structure that would generally wash out every time there was high water or if it did not do that would soon go to pieces because of the temporary makeshift nature of the construction.

Durability of concrete and its strength are its chief advantages when used for bridges or culverts. Most state highway departments have more or less standardized designs for small bridges and culverts so that after meeting foundation requirements a design appropriate to practically any locality where no greater span than 20 feet has to be provided for can readily be obtained from these various state highway standards. For that reason the following description will confine itself to the principles of culvert construction. If the farm needs are such as to need a structure from 18 to 20 feet in span, it is suggested that the intending builder communicate with his state highway department and see whether or not a certain standard design cannot be adapted to the particular requirements in question.

Types of Culverts. The simplest form of culvert is that made of precast pipe. Usually concrete pipe is the type employed. Pipe culverts are adapted to all sizes of openings from 12 inches upward to the largest size

of pipe made, providing the larger size will otherwise suit the location. No waterway openings smaller than 12 inches should be installed because smaller sizes easily become choked with leaves and other debris.

The box culvert, as the name implies, is merely a long box with concrete top, sides and bottom. Sometimes in building box culverts the concrete floor is omitted and the sides extended down a short distance into the stream bed. This, however, is bad practice where the location of the culvert is such as to expose it to handling a large

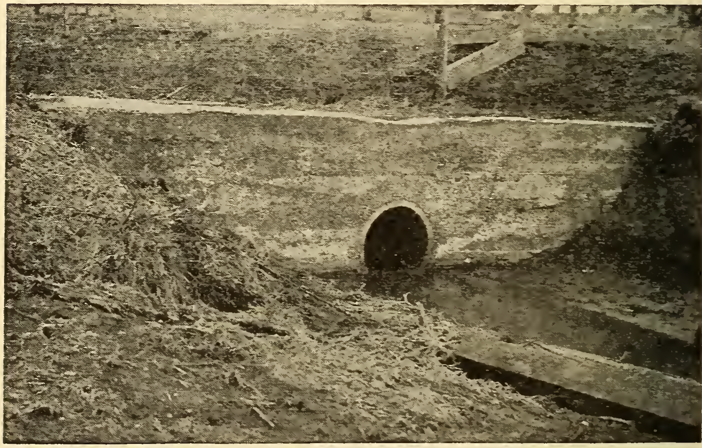


Concrete culvert under roadway, which serves also as a cattle passageway, making it unnecessary for stock to cross the roadway.

volume of water during a short period of time. In such a case the culvert is likely to be washed out by undermining. The box culvert is in effect a small bridge with top slab. As this top slab has to bear the heavy loads imposed upon it by the vehicles using it, it must be reinforced with steel rods or heavy mesh fabric. The box culvert is the most generally used of all concrete culverts because only simple forms are required and the concreting is easily done. The finished structure is also strong and durable.

Another type of culvert is the arch, which is different from the one just described because the top is circular instead of flat. There is one advantage in the arch culvert for small spans. In a small arch little or no reinforcing is required. Against this advantage is the disadvantage that form work is more difficult and costly.

The required area of waterway for culvert openings



Concrete pipe culvert with concrete headwall.

is given in an accompanying table. These figures are presented merely as a basis on which to estimate the approximate area of opening required.

Careful study of the drainage area which the culvert is to serve is necessary in order that determination can be made with reasonable accuracy.

Concrete Mixture and Other Requirements. For concrete culverts the proper mixture is 1:2:4. Pipe culverts can be installed when the necessary concrete pipe may be conveniently obtained from a nearby producing plant. It is not practicable, however, for the home worker to make his own concrete pipe. They

should be made of 1 part portland cement to 3 parts sand if no coarse aggregate is used and of 1:2:4 mixture where coarse aggregate is used. In installing concrete pipe culverts the pipe are laid in a carefully prepared trench properly curved at the bottom to evenly support the pipe. Back filling and roadway cushions must be carefully placed and compacted in layers so that the concentrated loads of vehicles will be distributed over a large area and not come directly on a small portion of the pipe.

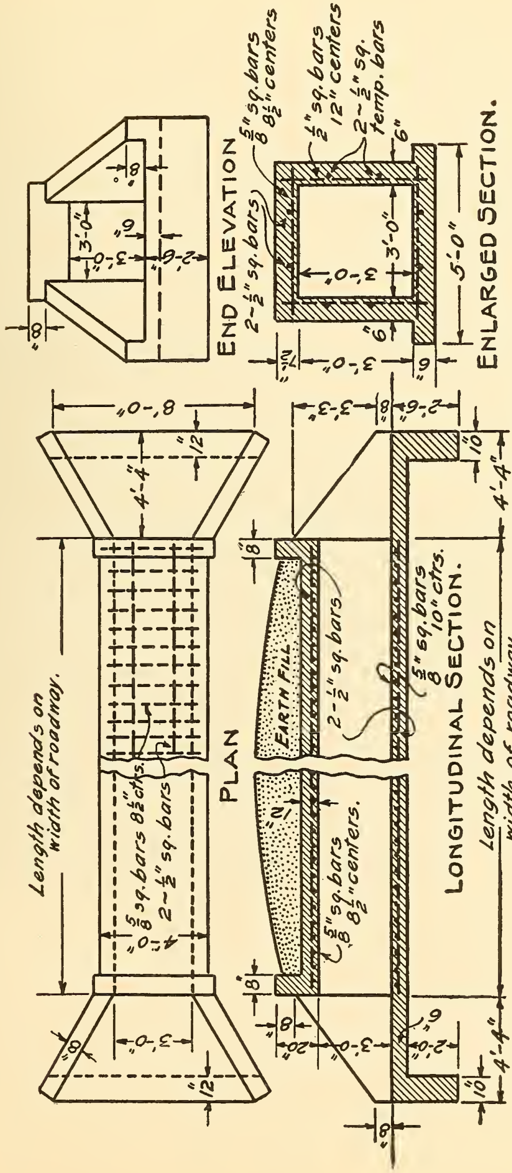
Foundations. For the smaller size of arch and box culverts in firm soil the side walls in themselves constitute sufficient foundation, but where soft or doubtful soil conditions are found and for the larger sizes of culverts it is well to provide a spread footing under the side walls. Often the culvert floor is considered as the foundation footing. In such a case the floor acts as a beam and should be reinforced in the same manner as the culvert top except that the steel is placed in the upper instead of lower part of the slab.

Forms and Reinforcing. The forms required for small culverts are so easy to build that they require practically no illustration. All flat slab or box culverts regardless of size should be reinforced. Reinforcing may be in the form of bars or woven wire fabric. As a rule such reinforcing is placed with its center point 1½ inches from the bottom of the slab. This applies to the top slab, but when the floor is reinforced the metal as already mentioned is placed the same distance from the upper face of the slab. Reinforcing should be bent down and up into side walls a suitable distance. It should be held the required distance from the form by means of block spacers and should be tied at intersections so that it will remain in correct position during concreting.

Wing Walls. For retaining the roadway fill or approach to the culvert and to prevent erosion by the stream, every culvert should have end or wing walls. Where concrete pipe culverts are used such walls are generally built straight and parallel with the roadway. The top thickness of end walls for pipe culverts should be not less than 12 inches and as a general rule the thickness at the bottom should be 4/10 the height of the wall. The foundation footing under the wall is made 6 inches

Simple box culvert such as would supply a want existing on many farms.

wider than the wall. End and wing walls for box or arch culverts are either straight and parallel with the road or flared at an angle to it. The flared wing wall is more effective in confining the roadway fill and should be used wherever practicable especially on the upstream end of the culvert. The top of the wing wall slopes to conform to the slope of the road fill which in general is 1 to 1½. End and wing walls are frequently reinforced in order to reduce the quantity of concrete required.



Detailed design of small concrete culvert.

The saving, however, with respect to such walls used as a part of small culverts is usually so small as to be more than offset by the additional labor and care necessary to shape and place the reinforcing.

A concrete floor should be built in all concrete culverts. Its even, regular surface assists to prevent choking of the waterway and erosion and undermining of the foundations. A vertical cutoff wall at each end of the floor extending down 2 feet is added protection against undermining. For very small culverts the floor is made continuous with the walls and thus acts practically as a foundation. In larger culverts the floor is laid usually as a 6-inch pavement between the walls.

In order to properly distribute concentrated loads the roadway covering over all culverts should be not less than 12 inches. This applies strictly to culverts on the farm and is not to be interpreted as the requirement for such culverts when placed on a main traveled highway.

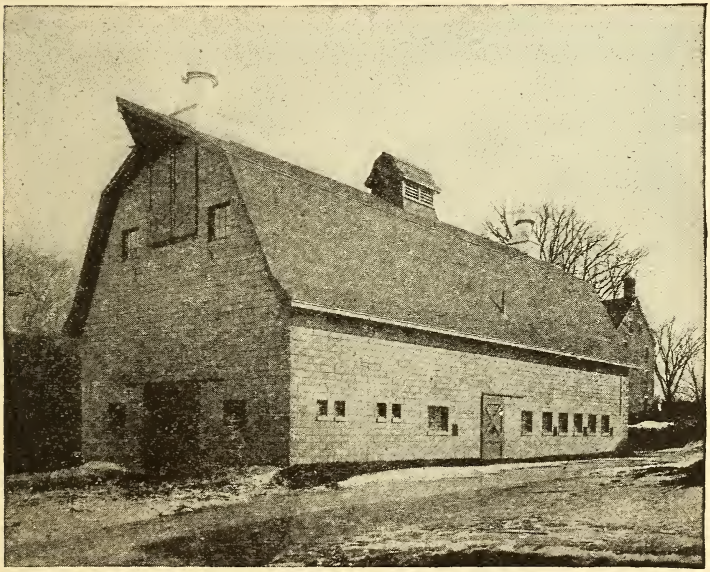
Care should be taken not to remove the forms nor expose the slab covering to the weight of traffic until the concrete has sufficiently hardened to be proof against failure.

SIZE OF WATERWAY REQUIRED FOR VARIOUS AREAS TO BE DRAINED

Area Drained	Area of Waterway Needed (in Sq. Ft.)		
	Steep Slopes	Rolling Country	Flat Country
10	5.6	1.9	1.1
20	9.4	3.1	1.9
30	12.8	4.3	2.6
40	15.9	5.3	3.2
50	18.8	6.3	3.8
60	21.6	7.2	4.3
80	27	8.9	5.4
100	32	10.6	6.3
125	37	12.5	7.5
150	43	14	8.6
200	53	18	10.6
300	72	24	15
400	89	30	20

CONCRETE BARNS.

General. Probably the most important structure in the farm building group is the barn. When the farmer specializes in milk production the dairy stock are usually kept in a barn provided especially for them. Where, however, farm stock includes many horses and dairying

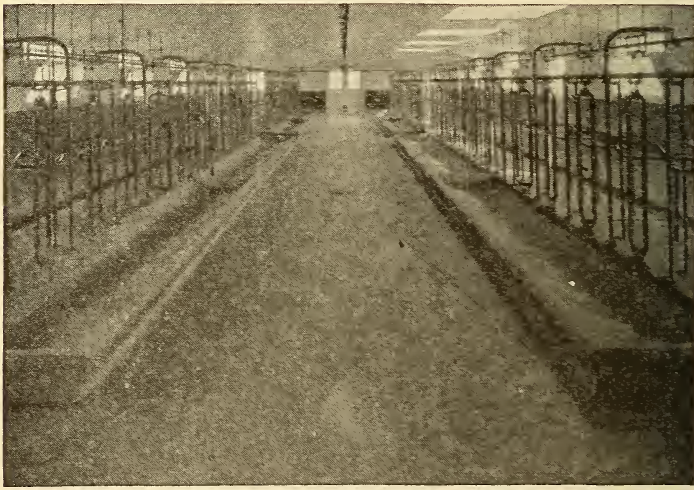


Another example of concrete block in barn construction. This structure is a general purpose barn.

is not a specialty, the so-called general purpose barn is a popular type. The general purpose barn probably has the greatest interest to most farmers and is a great convenience because it enables the farmer to carry on a great deal of his work within the walls of a single structure. However, dairy requirements in many states do

not permit cows to be stabled in the same quarters with horses or other stock where the litter is not removed daily, so progressive farm building planners have developed many practical designs that are a close approach to the ideal.

More consideration is given to good looks than formerly. Barns might just as well be made to look attractive as the reverse. The extra thought involved in

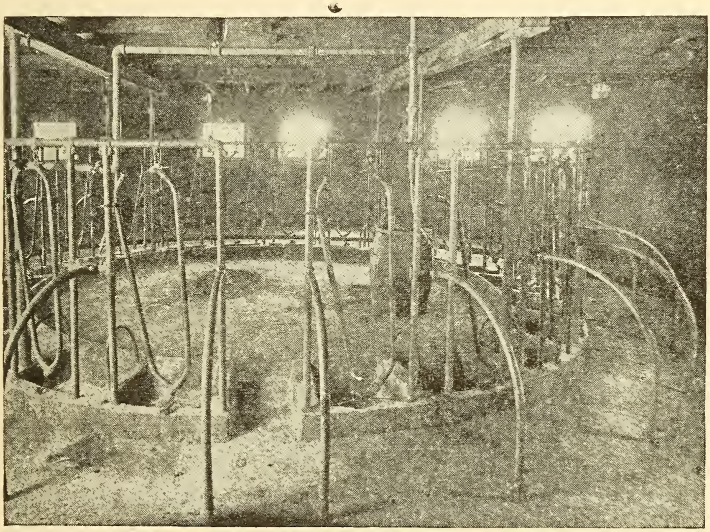


Interior of concrete dairy barn showing consistent use of concrete mangers, passageway and floors.

planning for looks calls for only a little more effort and adds greatly to the value of the structure, to the satisfaction of the owner, to the selling value of the farm and to the farm folks who must meet the building every day face to face.

Foundations. Everything must have a starting place. There is no better start for any farm building than a concrete foundation. This is particularly true of a building which is to house dairy stock, because only with

concrete construction can the high degree of sanitation necessary to the production of high grade milk be maintained. Although the all-concrete barn has arrived in some sections of the country, it will probably be some years before structures of this kind are numerous enough to be commonplace, but that day is coming and is much nearer than it was two or three years ago. The next best thing to the all-concrete barn is the barn having an



Interior of circular concrete dairy barn.

all-concrete basement and first story. In the general purpose barn this is ideal. It fits in well with the favor which is now being enjoyed by the plank frame barn which is also within the range of the average labor skill to construct; so much of the advantages of concrete in barn construction, especially in general purpose barns where the lower portion of the structure is to serve also as dairy stock quarters, can be secured by extending the foundation far enough above ground to make it actually

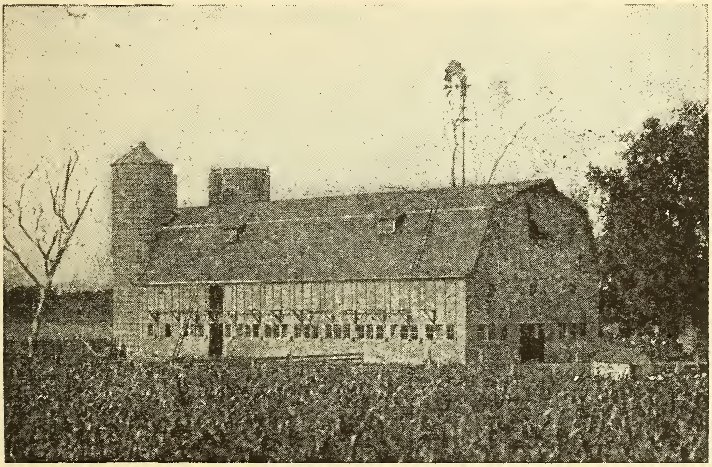
form the first story of the structure, then building a reinforced concrete floor to separate the stock from the haymow or upper portion of the building. This makes the first story concrete enclosed, with all the resulting protection against fire. Such a floor must be designed for the particular structure, but with this done the actual work of building can be carried on by anyone who is able to carefully follow plans and willing to observe every requirement of concreting practice.

Concrete block horse barn.

Barns may also be built of concrete block. Likewise they may be built of stucco on wood or metal frame.

Ventilation Important. In stock quarters it is very necessary that there be a proper ventilating system. This is particularly important in cold weather. The moisture laden air exhaled from the animals' lungs will condense on the concrete and in extremely cold weather will form frost which is evidence that there is insufficient ventila-

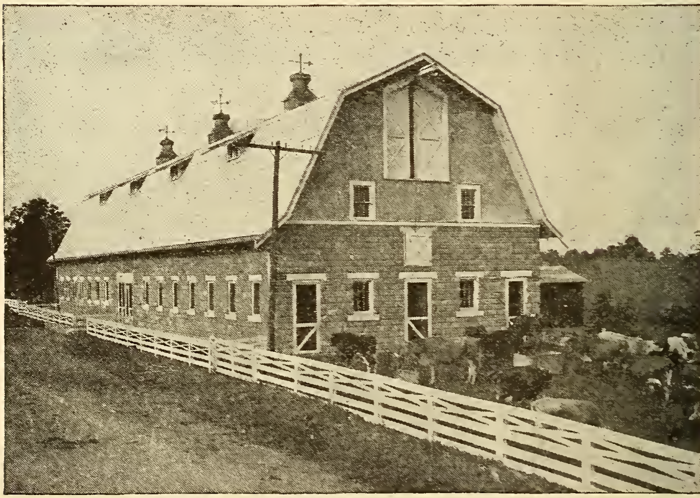
tion. Many persons think that when frost forms on the interior wall in this way it is an evidence of moisture coming through the wall. If a suitable system of ventilation is installed, however, this notion is disproved. The old style barn used to get all the ventilation it needed through cracks, but modern barns are built more nearly airtight so far as wall surfaces go and a proper ventilating system must be arranged. The haymow or



Concrete barn built of cement staves similar to those used in silo construction. The silos shown at the end of this barn are also cement stave construction.

upper portion of the general purpose barn does not need systematic ventilation like the stock quarters, nor does ventilation mean merely openings and outlets without any particular regard for their correct distribution. Some effective means must be provided for intake of fresh air, otherwise ventilation, which means the removal of foul air and the taking in of fresh air, cannot be accomplished. Unventilated or poorly ventilated quarters are disease breeders. Proper ventilating flues will have all the characteristics of a good chimney.

Interior Arrangement. In designing a dairy barn proper arrangement of the floor plan is important. It is usually desirable to place cows in two rows as this requires less labor in feeding and makes the handling of stable wastes easier. The cross section and plan shown represent a popular arrangement in which the cows face out. Some farmers prefer to have the cows face in, claiming that the light is better and the barn can be



This concrete block dairy barn is on the farm of an enterprising Indiana farmer.

made narrower. Choice seems about evenly divided with respect to the two plans. When the cows are faced out, two feeding alleys are necessary and one manure alley, thus increasing the labor of feeding, while decreasing the labor of cleaning the barn. The situation is exactly the reverse when cows face in; namely, there is one feeding alley and two manure alleys.

Windows. Windows in a dairy barn should be arranged to furnish light only, although when open con-

siderable fresh air will be admitted. They should be screened as should all other openings to prevent entrance of flies and thereby to insure that stock will be more contented when compelled to be housed the greater portion of the time. Sixty cows will find ample space in this barn, which is 35 feet wide. This is considered sufficient to provide proper working space in front of and between the two rows of cows. Any lesser width would crowd the feeding and litter alleys, while greater width would mean unnecessary expense for construction as well as continued extra expense for operation.

Construction Features. This plan is adaptable to monolithic concrete, concrete block or stucco on frame construction. It is planned for a one-story structure only and reinforcement required in the walls is merely that necessary to take care of temperature changes and consists of rods spaced 2 feet center to center in both directions and set diagonally as described elsewhere at corners of window and door openings.

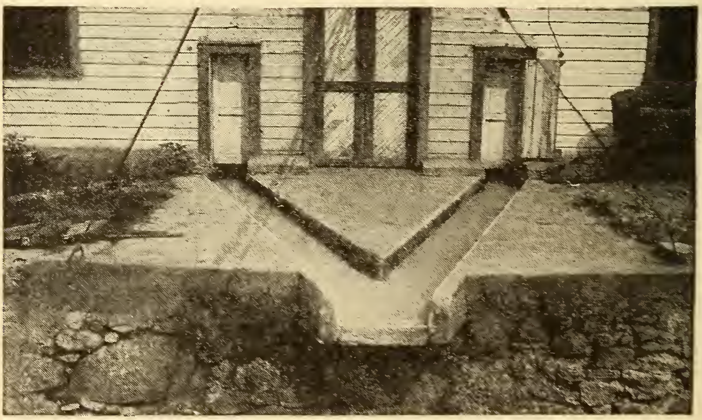
The depth and size of the barn foundation depends upon the weight of the structure. In any event it should go down to firm bearing soil and below possible frost penetration. The width of footing depends somewhat on the loads which walls have to carry and on the sustaining power of the soil. These subjects have been discussed under the head of foundations.

Perhaps the greatest hindrance to progress in design of dairy barns has been the tendency to follow the style of other buildings in the neighborhood, thus perpetuating faults and continuing incorrect practice with more or less waste and the resulting dissatisfaction. Every barn should be planned with particular reference to the service required of it, considering local conditions but disregarding local peculiarities which are often false guides. By making an effort to have every barn meet in the best

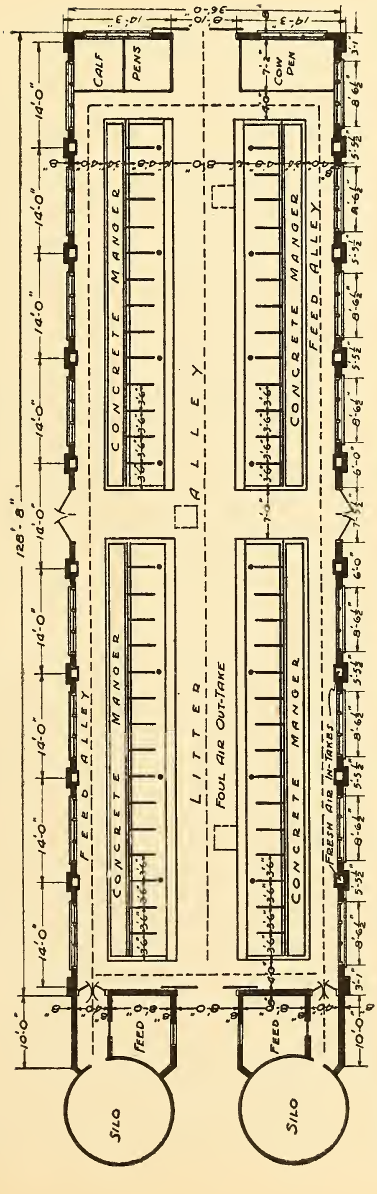
possible manner the particular needs in each individual case, a greater measure of convenience and lower cost of operation and maintenance will be secured.

Silos with respect to the dairy stock quarters are usually located so as to be connected to and continuous

Filling time is on at this monolithic concrete silo.



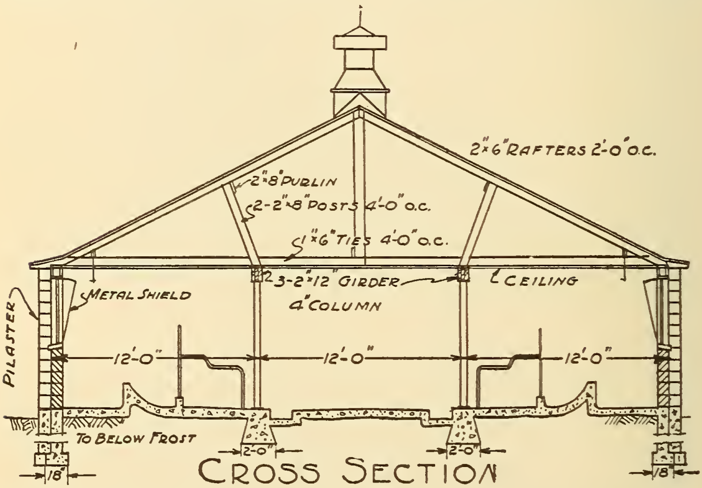
Manure gutters from the dairy barn converging to discharge their contents into the manure pit. Unfortunately this pit has not been built of concrete, so is probably losing a good portion of its valuable contents.



Plan for one-story concrete dairy which may be adapted to monolithic concrete block or stucco construction. This plan contemplates cattle facing out.

with the feed alley from the chute by which silage is thrown down. In the plan presented feed rooms are adjacent to each silo and the feed alleys connect with the silo chute as suggested above.

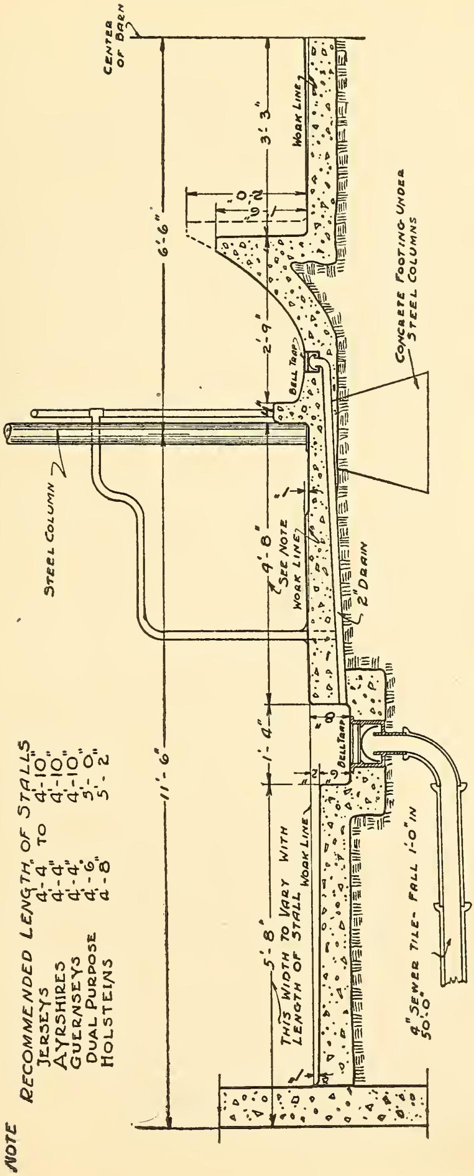
To adapt any plan to the requirements of the general purpose barn, arrangements should be made to shut off by a concrete wall the quarters of the dairy stock from the quarters of other live stock. The design may be expanded by certain fixed units, the only difference being



Section of concrete dairy barn corresponding to the plan on page......

in the way the interior space is disposed of. In such a plan it may be more convenient to locate the silo at the center of one side of the barn so feeding of silage will be convenient with respect to both classes of animals housed.

Circular Barns. Both dairy and general purpose barns of the circular plan have been increasing in popularity of late years. There are many examples of such structures throughout the country, a large number of

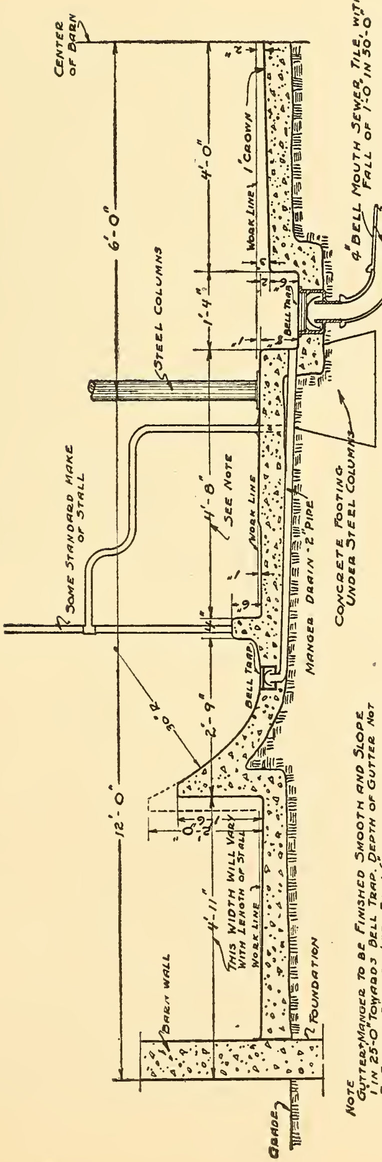


Section of dairy barn floor showing arrangement of alleyway, stall and mangers when cattle face in.

which have been built of concrete block or concrete applied in other ways and the usual interior arrangement of such a barn is to have the silo at its center. This plan is ideal with respect to ease of feeding silage. There is little carrying of the material required to place it in the mangers.

Size of Stalls. Length of cow stalls usually depends on the size of stock kept. Three feet 6 inches is usually considered the standard width although for small stock 3 feet 4 inches is sometimes considered standard. Specing of barn bents or posts sometimes makes it necessary for the designer to vary the width of stalls a trifle. A 14-foot bent accommodates 4 stalls $3\frac{1}{2}$ feet wide, a 10-foot bent 3 stalls 3 feet 4 inches and a 12-foot bent 4 stalls 3 feet wide. The length of stall should vary with the breed of cow which is to occupy the stall. Guernseys and Jerseys are kept clean and sleep comfortably in stalls $4\frac{1}{2}$ feet long, while Holsteins and the larger breeds of cows require a stall 5 feet deep. Floors should have a slope about 1 inch between the foot and the head of the stall to cause liquids to flow into the manure gutter. Gutters are usually 16 to 18 inches wide so that they can readily be cleaned with an ordinary shovel. They should have a slope of $\frac{1}{16}$ inch per foot for drainage. This is sufficient to carry off water when the stable is flushed out. Gutters should connect to a pipe line which leads to a concrete manure pit. When the row of stalls is over 100 feet long it is best to have several points of drainage to the pit.

Mangers of Concrete. Concrete mangers have now practically replaced those of wood in the modern dairy barn. Although they cost more in the first instance than wood they are permanent and sanitary. Metal mangers also are used. These are sometimes hinged so as to be easily raised out of the way for cleaning. Floor man-



Section of dairy barn floor showing arrangement of alleyway, stall and mangers when cattle face out.

gers are used to serve as troughs for watering the stock. Concrete mangers should be made continuous, with a drain at one end for cleaning out when flushing with water. The slope should not be so great as to cause water to run too much to one end. The manger should be nearly 3 feet wide. If it is too wide it will be necessary to walk in the feed trough to stanchion up the cows. The front of the manger may be from 18 inches to 2 feet high. Back may be from 4 to 12 inches high. In the latter case it is cut down where the stanchions fit so as to allow the animals to lie down comfortably. The curb prevents the animals from throwing feed under their feet and thus wasting it.

Feed alleys are often made too narrow. When the alley is used for no other purpose than to carry hay and grain to the stock 3 feet is wide enough but less than this makes a cramped passageway. If space can be spared 4 feet wide will be better.

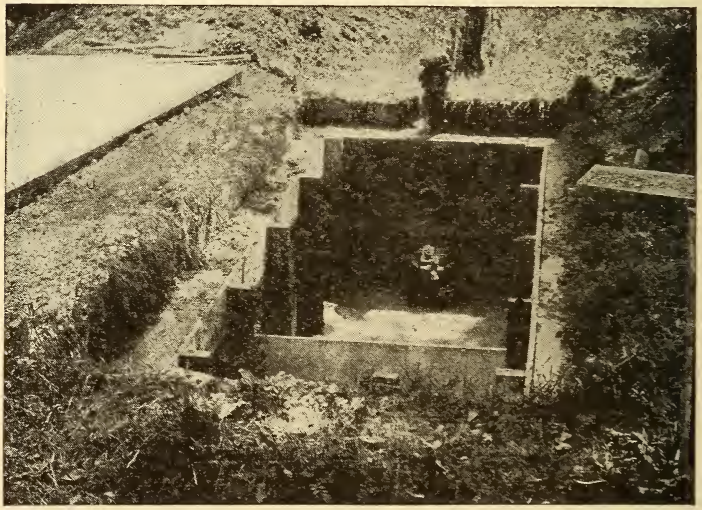
CONCRETE SEPTIC TANKS

Because the farm home does not enjoy the advantages of the city one, which can be connected with the city sewer system, is no reason why the farm home should not have the conveniences of indoor toilet, bath and kitchen sink. These are regarded as necessary appointments of the home designed for comfort and convenience and are just as feasible on the farm as in town, if proper provision is made to dispose of the natural household wastes. There is nothing that contributes more to the danger of disease than such careless disposition of household slops as throwing them out on the ground where flies can infest the decomposing material and in turn, carry it around through the house, contaminating food and thus endangering health. Aside from the actual danger of such a possibility is the disgust attending it. Careless methods of disposing of household wastes, such as garbage and other refuse of housekeeping, have caused epidemics of disease with resulting heavy and needless waste of human life.

Concrete septic tanks solve the problem of disposing of household wastes from a modern plumbing system on the farm where of course a city sewer is not available. It must not be thought, however, that the concrete septic tank is a cure-all for the house sewage problem, that is, it is not as good as a modern sewerage system and is intended only as the best substitute where another sewerage system cannot be made use of. Properly built and cared for, a concrete septic tank has many advantages over the cesspool. The cesspool merely holds its filthy contents until necessity compels it to be emptied and

the contents disposed of in some manner. Usually disposal is accomplished by pumping out the cesspool into a tank wagon and distributing the wastes over the ground, allowing soil absorption and sun to take care of final disposition. At best this is a dangerous and offensive practice.

The concrete septic tank will transform the wastes from the house plumbing so that their final disposal in



View of concrete septic tank with syphon set and inner forms in position. The wall dividing the two compartments has not yet been placed.

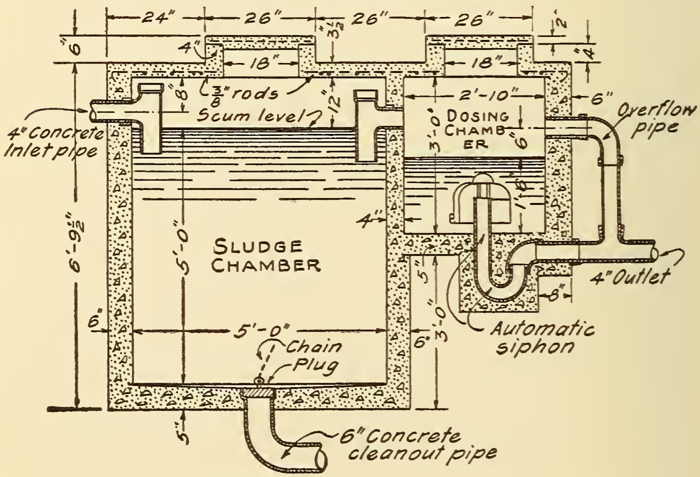
a safe, sanitary manner is a simple, almost natural, process. Concrete septic tanks are not hard to build, nor are they expensive. Once in operation, they cost little or nothing to keep in order and may be relied upon to give satisfactory service indefinitely. The principle on which such tanks operate is one of rotting or decomposition. That is, the solids and semisolids which enter the first compartment from the house drain are digested or

liquified by certain bacteria such as develop in all vegetable or animal matter when it starts to rot or decompose. Usually a septic tank is rectangular and divided into two compartments as shown in an accompanying illustration. The first, or left-hand, compartment is frequently referred to in several ways. Generally it is called the settling chamber or "sludge" chamber. The second, or right-hand compartment, which is smaller than the first, contains a device known as a siphon and for that reason is called the siphon or "dosing" chamber. Some so-called septic tanks which have been recommended as suitable for handling farm house sewage have been built without the siphon fitting shown in this second compartment. For reasons which will be made plain later, such tanks become—once they are filled—nothing but continuous flow cesspools, and therefore the effective final disposal of wastes cannot be accomplished because of clogging of the soil in the disposal field, due to continual trickling of contents from the tank. The siphon chamber receives the overflow from the first compartment and because of the siphon, which is automatic in operation, is emptied at regular intervals into a tile line leading to a disposal field where the discharges leak out through the open joints of the tile line and so seep into the soil where soil bacterial action does the rest.

Experience has proved that in the septic tank sewage will, if confined in a practically airtight and dark compartment, soon commence to break up, due to development and action of bacteria. These feed, as it were, upon the solids and semisolids in the wastes, thus converting them into gas and relatively harmless compounds. It must not be understood, however, that this bacterial action destroys disease germs. The discharges from the tank through the operation of the siphon must still be

properly cared for to prevent them from being a possible source of disease.

Practically all successful septic tanks embody the features of design shown in the accompanying illustration. They may appear somewhat different but in essentials are the same. Sewage must enter from the house at one end of the tank and leave at the other end. Flow through the tank should be slow and as uniform as possible, otherwise the solid matter will not have time to settle. Sewage must enter the tank below the normal



SECTION A-A.

Section through concrete septic tank.

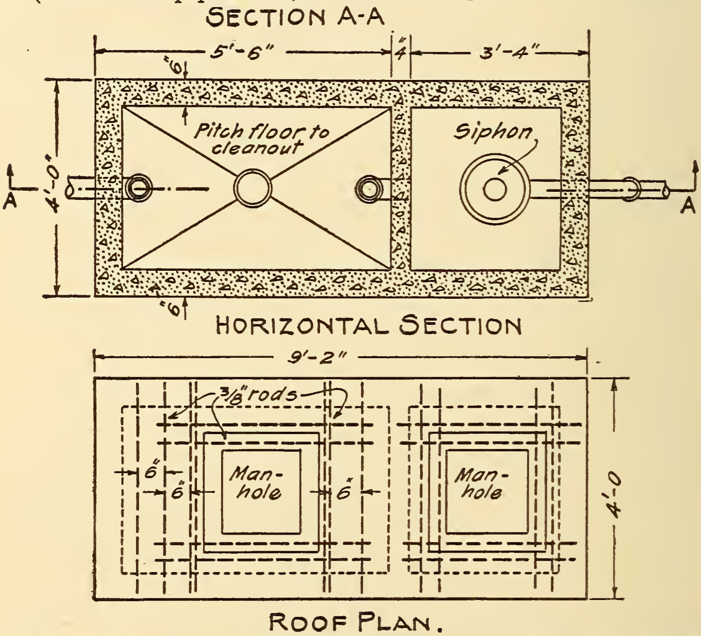
level of contents. A rectangular form of tank is best. Depth should not be less than 4 feet below the opening of the pipe which discharges wastes into the tank. The total depth of fluids in the first compartment should not be less than 5 feet. If practicable, a greater depth is desirable. After having remained in the first compartment a sufficient time, solid matter is destroyed and the liquids overflow into the second, or siphon compartment. From this compartment the discharges must be carried

by a tile made of dense, non-porous tile laid with cemented joints to the area where final disposition is to be made of the wastes. This is generally referred to as the disposal field.

If surroundings are such that a certain area of ground can be set aside for the purpose, surface irrigation may be used. This means allowing the liquids discharged from the siphon compartment to flow over the land where they are acted upon by the sun and soil bacteria. In such a method of disposal it is necessary to select an area where all wastes may not immediately be washed into some nearby stream, thus fouling the water. Perhaps the best method is subsoil or subirrigation disposal by tile lines such as indicated in another sketch, which shows the general method of laying tile lines. As a rule, this system requires less attention and the discharges from the tank are entirely out of sight at all times.

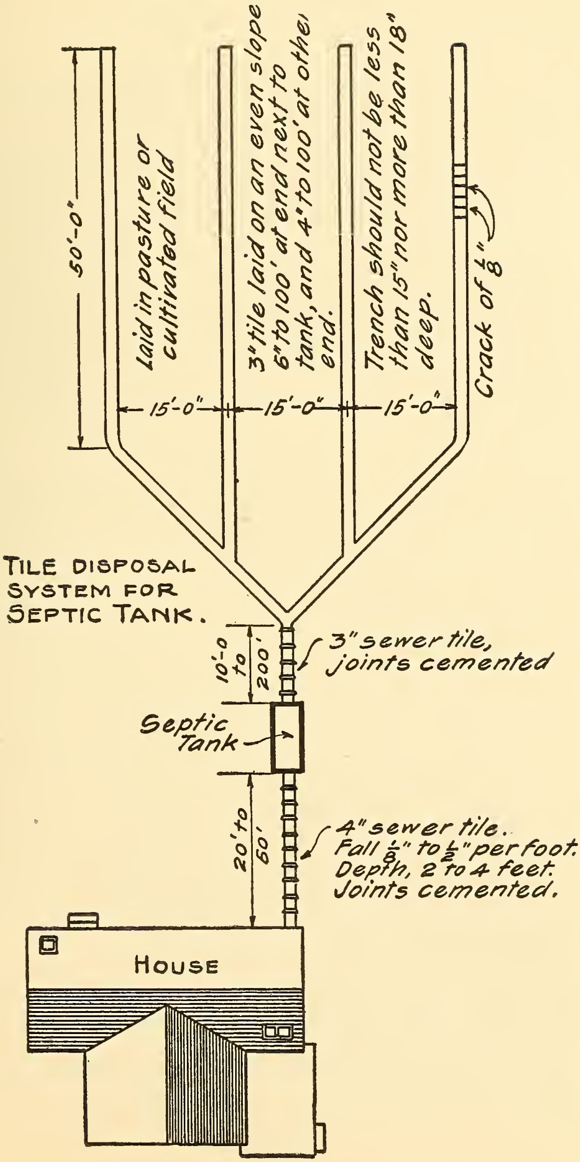
Once started, the septic tank is self-operating on account of the automatic siphon. Siphons can be so timed that the frequency of discharge of contents from the siphon compartment can be at, say, 4, 6 or 8-hour intervals during the 24 hours. These intermittent discharges cause the entire contents of this compartment to be emptied into the tile line and thereby result in flushing it and giving the soil also a chance to rest, as it were, between various discharges, thus preventing it from being clogged up. Experience seems to prove the desirability of building a septic tank of sufficient capacity to contain 24 hours' flow of sewage from the average house. Capacity is usually determined by estimating that the discharges into the tank will range from 30 to 50 gallons per person per day. The length of the tank should be about twice its width so that uniform velocity of flow through it may be obtained.

Concrete is by all odds the best material for septic tank construction. It is necessary first that a septic tank be free from masonry joints which, if by chance, are not properly laid, will result in leakage and hence possible contamination of drinking water due to the filtering of impurities from the tank through the soil. Inlet pipe to (and outlet pipe from) the first compartment or sludge



Horizontal section and roof plan showing reinforcement for concrete septic tank.

chamber, is a 4-inch concrete tile with T head so that the lower portion of this head will extend down into the tank contents and thus prevent disturbing of the scum in this tank when house sewage enters. The outlet pipe is of the same material and form to prevent overflow from drawing out any of this scum, which must be retained in the tank and not be disturbed any more than



Sketch showing location of tank with respect to residence and method of installing tile in disposal field.

necessary, as it is the culture bed for the bacteria which act on the sewage.

Form construction is not unlike that which would be required in building a cistern such as is described elsewhere. Suitable provision must be made for setting the siphon and the pipes connecting it with the tile line leading to the disposal field. Walls of the septic tank are 6 inches thick and the floor slopes from 6 inches to 5 inches at the center where it is connected with an outlet that may be used annually or oftener if necessary to remove the accumulations at the bottom of the tank. Usually once a year is all the cleaning that such a tank requires if operating effectively.

Reinforcement for the side walls may be ¼-inch round rods placed every 6 inches center to center, both vertically and horizontally and across the tank floor up into sides and ends. Reinforcement for the roof or cover is ⅜-inch round rods spaced 8 inches center to center. The cover slab for the manhole is cast separately and reinforced with ¼-inch round rods or mesh. In installing the tank, the tile line leading from house to the tank should be laid with absolutely tight cemented joints and if the tank must of necessity be so located that it is within 25 or 50 feet of the well, the tile leading from the tank to the disposal field should be laid with tight cement joints until the end of this line has reached a point at least 200 feet from the well furnishing the house water supply.

The various state departments of health issue bulletins illustrating and describing septic tanks and the proper method of installing and operating them. These bulletins can be obtained from these departments free of charge.

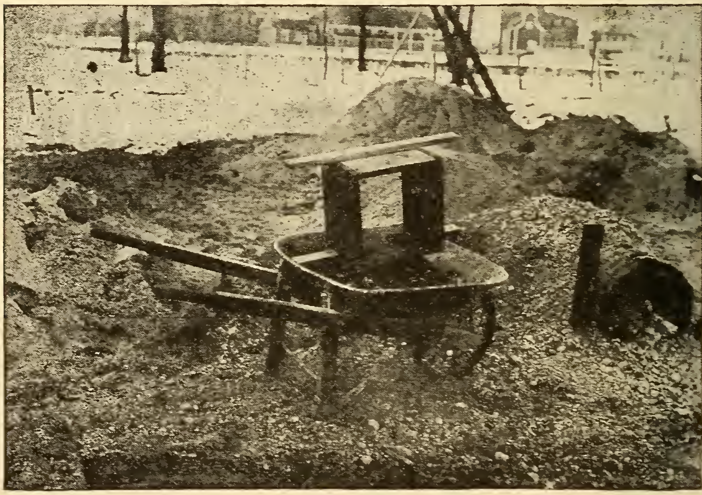
HOW TO DO CONCRETE WORK IN COLD WEATHER

Many persons think that with the approach of cold weather the possibilities of concreting are past for a certain season. This is true only in part, depending upon the severity and duration of the cold. Naturally the farmer will not care to continue outdoor construction during the winter months, although there are many kinds of concrete work, such as building stock tanks, feeding floors, etc., which may be done during the intervals of milk weather providing there is no frost in the ground upon which the construction is to be erected or made.

Work That Can Be Done in Cold Weather. It is possible to successfully lay concrete foundations and to complete construction which must be finished for use during the winter, even after freezing weather has set in, provided certain precautions are rigidly observed. To appreciate the importance of these precautions it is necessary to call attention to the fact that concrete hardens slowly when the temperature is 55 degrees or lower and hardening is retarded in proportion to the corresponding low range of temperature until the freezing point is reached. On the other hand, concrete hardens with desired rapidity in the presence of warmth and moisture; therefore, any means that can be applied to maintain these desirable conditions for say 48 hours after placing the fresh concrete, contributes to the possibility of successfully doing concrete work under conditions of low temperature that would otherwise be unfavorable.

Arranging for Concrete Work in Cold Weather. One of the shortest cuts preparatory to carrying on some con-

crete work in cold or freezing weather is to arrange to store sand and pebbles somewhere indoors so as to prevent the material from freezing or becoming filled with frost. If such facilities cannot be arranged, the materials may be heated in one of several ways immediately before combining them, so as to thaw them out and raise the temperature of the materials to a point that will give enough warmth to the concrete when mixed so that with



In cold weather aggregrates may be heated by piling on and around an old stove pipe and building a fire in the pipe as suggested in this illustration.

other protection it will have time to harden before it can be affected by freezing.

Heating Materials. One of the easiest ways to heat sand and pebbles is to take a section of old smokestack, lay it on the side, build a fire inside of it and pile the aggregates over and around this improvised stove. Cement being only a small part of the concrete mixture need not be heated. Care should be taken not to heat the aggregates above say 200 degrees becaus some sands

and pebbles or broken stone are injured by overheating. Mixing water also must be heated. This can be accomplished in several ways. If there is a large feed cooking kettle on the place this often will serve the purpose. Or if any of the buildings have a heating plant operated by a steam boiler, a steam pipe can be run into a barrel and the water kept near the boiling point until used. The aim should be to heat the aggregates and water so that when the concrete is mixed and placed it will have a temperature of about 80 degrees. No aggregates should ever be used in a concrete mixture if there is frost in them.

Protecting Against Freezing. For mass construction such as foundation walls, the freshly placed concrete will not need as much protection as will be required for work more exposed, like floors and pavements; therefore, after distributing the concrete in the foundation trench or forms all that may be necessary, unless the temperature is below freezing, will be to cover the top of the concrete with 10 or 12 inches of hay or straw laid on building paper or canvas. If the forms are tight the heat given to the concrete through warming of materials will afford sufficient protection to prevent freezing during the period required for early hardening; otherwise, and if temperature is likely to go far below freezing, it is necessary to hang canvas, building paper or similar covering over the outside of forms to prevent immediate contact of severe cold.

The forms should be clean and free from ice or snow before concrete is placed. During the periods of mild weather, barn floors may be conveniently made in such sections that a portion of the old barn floor may be used while the new is in progress. Even with all desirable precautions taken, concrete will harden more slowly in cold than in warm weather and it will be necessary to

keep concrete floors made in winter out of use longer than if they were laid under more favorable conditions.

Fixing Up a Winter Workshop. Concrete block and fence posts may be made indoors during the winter in a cellar or shed where the temperature can be maintained at 50 degrees. Utmost care must be taken to prevent fresh concrete from freezing during the first two or three days. One of the best methods is to store in a tight room and cover the block or posts with 12 inches or more of straw and to make certain that the temperature does not drop below 50 degrees. No precaution is too insignificant to be observed in winter concreting, but the following summary of essentials should at all times be uppermost in mind:

Heat hastens the hardening of concrete. Cold retards it.

Temperatures which may not be low enough to produce freezing often delay hardening very materially.

Do not expect concrete placed under unfavorable temperature conditions to be safe for use as soon as though placed during warm weather.

Do not use salt in the mixing water. This will help to resist low temperature but is likely to result in a concrete of doubtful strength.

Examine all aggregates before using and make certain that they are free from frost or frozen lumps.

Place each batch of concrete immediately after mixing.

Temperature of concrete when placed should be at least 80 degrees.

If the concreting is unavoidably delayed or when it has been finished, immediately give the work all required protection by such covering as necessary to prevent freezing for 48 hours.

Examine the work carefully before removing forms. Frozen concrete often appears like thoroughly hardened concrete. Applying hot water or the flame from a blow torch to the concrete surface will disclose whether it is hardened or merely frozen.

Whenever buildings may be heated either by continuous heating from a steam pipe, boiler or other source of supply or by placing small oil stoves or other portable means of heating, such precautions will give added assurance of success.

CONCRETE SILOS

Silo Requirements. Once a silo marked a dairy farm, but when farmers found out that any live stock would not only eat but thrive on silage if judiciously fed, the silo became largely the mark of an up-to-date farm.

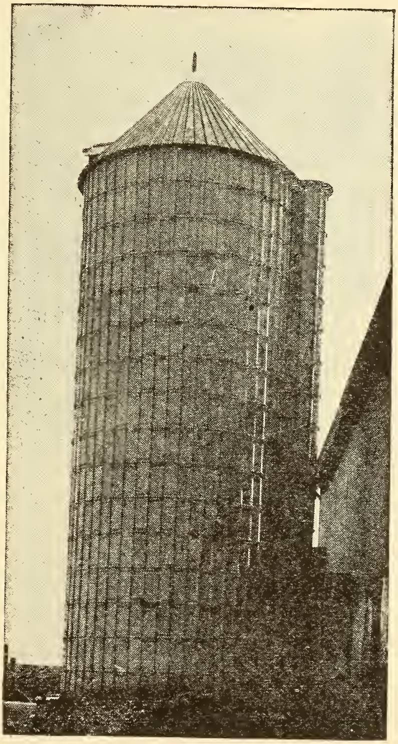
The advantages of silos are almost too numerous to mention. Practically every farmer who has built one and enjoyed its advantages for a little while is able to name a number of reasons why no farm where live stock is kept, especially dairy cattle, can afford to be without one.

A silo 60 feet high and 14 feet in diameter will hold approximately 400 tons of silage—400 tons of clean, succulent fodder that can be kept for feeding until needed and when most needed, and frequently it is most needed during the summer when pastures have dried up and grass is scarce or short.

Any kind of silo that will keep silage is a good investment from a certain standpoint but today investments are viewed largely from the standpoint of continuous profit with least maintenance and a concrete silo, being permanent, not only preserves feed but maintains profit longest because requiring little or no maintenance.

The best silo will be airtight, moisture-proof, fireproof, frost-proof, strong, durable, require little or no maintenance, be round in shape, have smooth exterior walls, and be permanent. Frost-proofness is largely governed by location. Silage will freeze in some latitudes to a greater or less depth in any silo regardless of the building material used. This is because economy of construction prevents making the walls thick enough to

resist freezing during long spells of the most severe weather, but the amount of freezing in various types of silos is usually so small as to be negligible. Besides, freezing does not hurt silage if it is fed as soon as thawed



Cement stave silo with cement stave chute.

out and not allowed to freeze and thaw several times before feeding.

Monolithic Concrete Silos. Concrete can be used in a number of ways in silo building. Either the single wall monolithic silo may be built, or the double hollow monolithic wall, or solid or hollow concrete block wall, or

cement plaster wall, or cement stave. Any one of these ways of using concrete if used effectively will produce a silo that will have most of the qualities of the ideal silo described, because concrete is moisture-proof, rat-proof and fireproof. With the modern commercial silo building equipment, perfect round structures are easy to build.

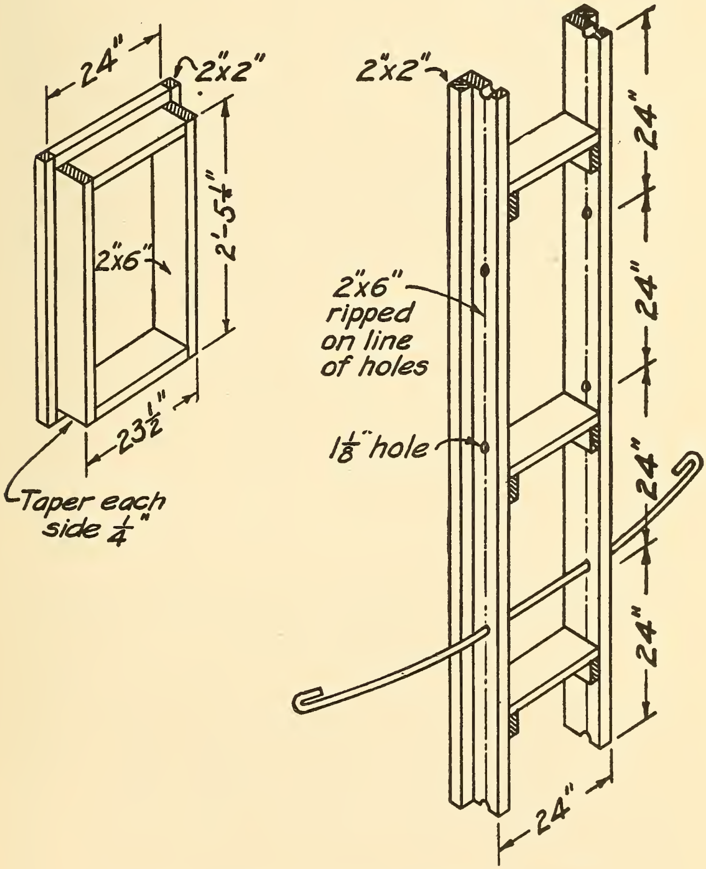
Some types of silos other than concrete require no end of maintenance annually if they are kept in condition fit for use. When empty they are likely to blow down at any time because they lack the necessary weight for stability. In addition they cannot be expected to have a long life in service because the materials of which they are made or the manner of using those materials prevents any approach to permanence.

First, we will consider the monolithic silo which, without intending comparison unfavorable to the other types of concrete silos, probably comes in for special preference because, as its name implies, it is one single mass when finished and possibly the most stable, enduring structure of the kind that can be built.

Although handy farmers can put up their own concrete silos, regardless of the particular way in which concrete is used it is always best to give the work to a contractor who specializes in it. A certain amount of suitable equipment is required which the average farmer may not find it profitable to provide just to build one or two silos. In some states the local department of agriculture has bought commercial silo forms and hires them out to persons desiring to build concrete silos, and sometimes furnishes one of the agricultural department representatives to advise upon or to supervise the work while in progress.

However, the farmer who decides to build his own monolithic concrete silo will find concrete construction admirably adapted to his purposes and abilities. With

the exception of an experienced foreman, or the supervision of the farmer himself if he is skilled in the fundamentals of concrete practice, nothing but ordinary labor



Details of form for continuous doorway openings.

is needed. The usual farm help can readily do the work. Sand and pebbles are on the farm or can be had for the cost of digging and hauling.

DIAMETER OF SILO REQUIRED TO FEED VARIOUS NUMBERS OF ANIMALS

Diameter in Feet	Approximate Minimum lbs. to be Fed Daily	Dairy Cows	Beef Cattle	Stock Cattle	500-lb. Calves	Horses	Sheep
		Minimum Number of Each Kind of Stock to be Fed from Each Size Silo					
10	525	13	21	26	44	48	175
12	755	19	30	38	63	69	252
14	1030	26	41	52	86	94	344
16	1340	34	54	67	112	122	446
18	1700	42	68	85	142	155	567
20	2100	53	84	105	175	191	700

APPROXIMATE CAPACITY OF SILOS

(Diameter is shown at the top of the columns and depth at the left)

Height of Silo Feet	10 Feet Tons	12 Feet Tons	14 Feet Tons	16 Feet Tons	18 Feet Tons	20 Feet Tons
	Inside Diameter of Silo in Feet and Capacity in Tons					
28	42	61	83	...	...	...
30	47	67	91	...	...	...
32	51	74	100	131	...	...
34	56	80	109	143	...	...
36	61	87	118	155	196	...
38	66	94	128	167	212	...
40	70	101	138	180	229	280
42	...	109	148	193	244	299
44	...	117	159	207	261	320
46	...	...	170	222	277	340
48	...	...	...	236	293	361
50	...	...	...	...	310	382

QUANTITY OF SILAGE REQUIRED, AND ECONOMICAL DIAMETER OF SILO FOR THE DAIRY HERD

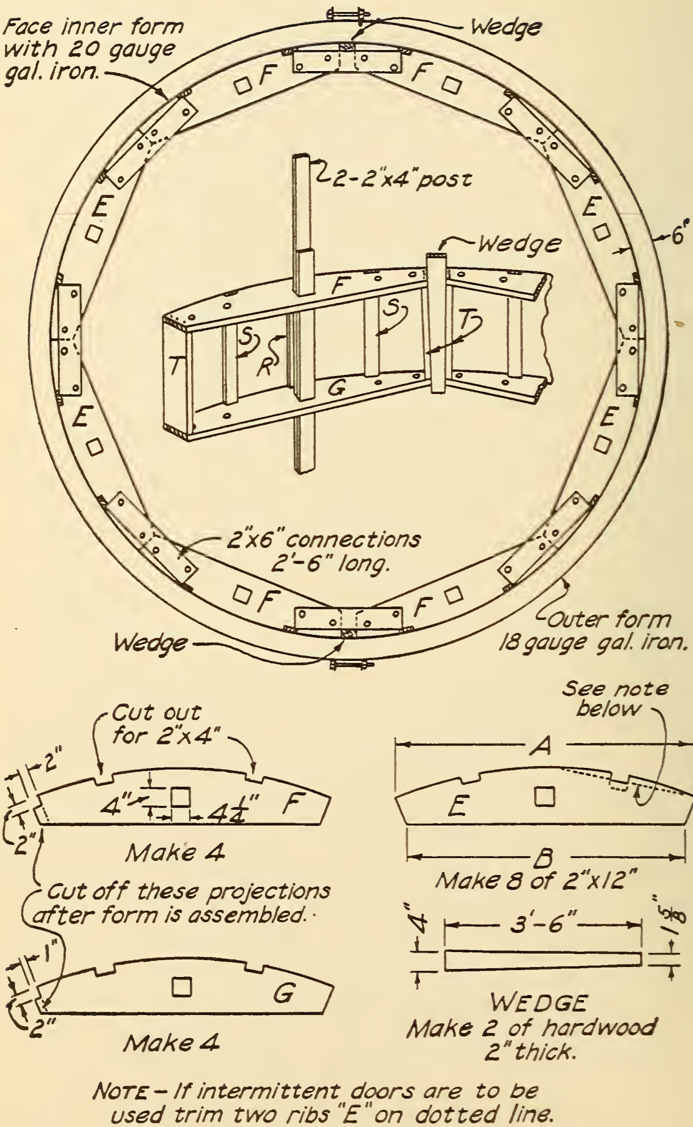
No. of Dairy Cows in Herd	Feed for 180 Days: Estimated Tonnage of Silage Consumed Tons	Size of Silo: Diameter Feet	Size of Silo: Height Feet	Feed for 240 Days: Estimated Tonnage of Silage Consumed Tons	Size of Silo: Diameter Feet	Size of Silo: Height Feet
13	47	10	30	63	10	36
15	54	11	30	72	11	36
20	72	12	32	96	12	39
25	90	13	33	123	14	37
30	108	14	34	144	15	37
35	126	15	34	168	16	37
40	144	16	35	192	17	39
45	162	16	37	216	18	39
50	180	17	37	240	19	39
60	216	18	39	288	20	40
70	252	19	40	336	20	46

What diameter of silo to choose is governed by the number of animals to be fed, the height of the silo and the length of the feeding season to be provided for. Whatever the dimensions, they should be such as to accord with the number of animals to be fed that daily feeding operations will insure the removal of at least a 2-inch layer of silage daily.

Accompanying tables show the diameter of silos required to feed various numbers of animals, the quantity of silage required, and economical diameter of silo for the dairy herd, and approximate capacity of silos of various heights and diameters.

Type of construction has nothing to do with location. A silo should, of course, be located where it serves the greatest convenience in feeding. At one end of the barn or at the middle at one side, connected to the barn by a short passageway usually solves the problem of location. The greatest convenience is found when the passageway from the silo to the feed alley in the barn is continuous.

The site and size of the silo having been decided upon, the area to be excavated should be marked out. A sweep or string with marker at one end and the other attached so that it will swing freely from a stake at the desired center of the silo can be used to lay out the line corresponding to the structure's circumference. This area should then be excavated four or five feet so that the floor or bottom of the silo will be about that distance below ground level. This is desirable because the height of the silo above ground is reduced by this amount, thus making a shorter distance through which to haul scaffolding and other equipment when building; it also makes the distance shorter for blowing the cut silage when filling the structure, and insures that the foundation starts below frost level and probably on good firm soil,



Details of inner form for home made silo form

Five feet below ground is as great a depth as desirable because when feeding the last silage out it is inconvenient to throw it through a greater height.

At the center of the floor provision should be made for a drain that will connect with a line of tile so that any surplus liquids from the silage may be led away to some outlet. Too great an accumulation of these liquids in the silo subjects it to the bursting pressure of this liquid content. The drain should be trapped with an ordinary gooseneck or similar trap to prevent air from entering the drain.

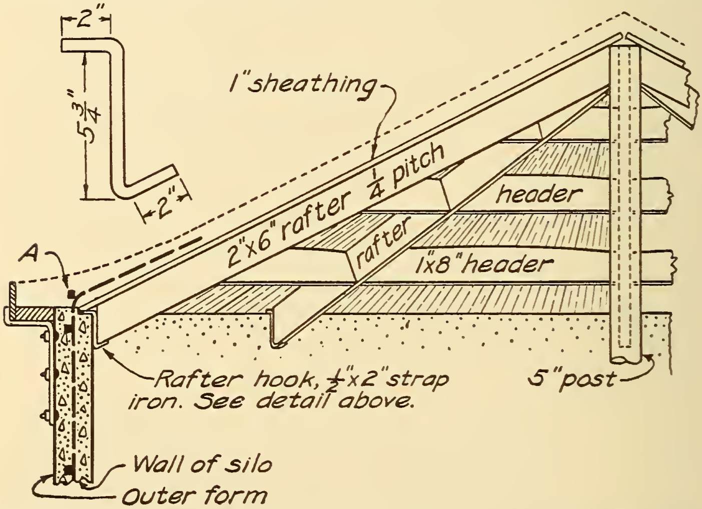
No forms will be needed except for the exterior wall face below ground if the earth where the excavation for the foundation is made is firm enough to be self-supporting. If it is not that firm then the excavation will have to be made larger as shown in one of the illustrations so that outside as well as inside forms can be set up. This sketch also shows the width and thickness of the average footing and the thickness of the floor; also the method of connecting trapped tile drain to the outlet at the center of the floor.

If no outside forms are used below ground, care must be taken when placing concrete not to knock down any of the earth into the concrete, thus producing pockets in it. For floor and footing a 1:2½:5 concrete is used. The table of mixtures and the explanation of proportioning and mixing concrete explain what this means.

If the ground on which the silo is built is not perfectly firm so as to provide good support for the structure, a wise safeguard is to widen the footing to 3 or 4 feet and to reinforce it with ⅜-inch round steel rods, 30 or 40 inches long, depending upon the width of the footing. These rods should be laid 8 inches apart across the footing and about 1¼ inch from the bottom. As the concrete is being placed for the footing, vertical re-

inforcement in the form of ⅜ or ½-inch square rods are set along a line corresponding to the center of the footing 30 inches apart so that as concreting progresses these rods will be in a position at the center of the wall and project into it.

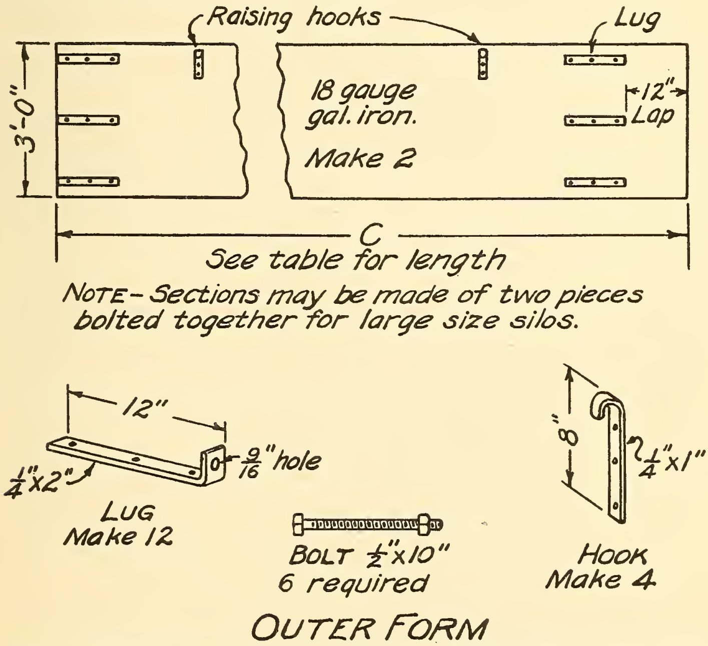
Twnety-four hours or more after the footing has been placed, concreting of the walls may begin. The length of time depends on the weather. In moderately warm, pleasant weather twenty-four hours is sufficient time,



Part sectional and perspective sketch showing method of setting form for concrete roof.

while in cold weather twice as long may be necessary. Before the walls are started the floor should have been laid and when concreting of the walls is begun, the surface of the footing should be brushed free and clean of loose material and thoroughly wet, then painted with a mixture of cement and water mixed to creamlike consistency so that there will be a good bond between footing and concrete for the wall. For walls a 1:2½:4 concrete is used.

Home made forms can be built by any person having average skill with carpenter tools. The forms for the courses are usually made 36 inches deep and in two or more sections. This depth makes it easy to place 32 inches of concrete at each setting of forms, the remaining 4 inches being an allowance for lap of forms over the concrete of the course last placed.



Some details of the outer form for home made silo forms. This form, as described in the text, is made of metal.

To get the correct curve for the inner form the usual practice is to mark out a circle on a level floor by using a sweep similar to that described for laying out the circumference of the silo when making the foundation excavation. This circle should have the same diameter as the inside diameter of the silo for which the forms are to be made. The sweep also serves to mark the pattern for

the ribs, E, F, G, as shown in an accompanying illustration. When these ribs have been sawed out to shape, each of the sections S which make up the inner form is built of 2 by 6-inch studding, indicated by T. The pieces S are set into the ribs while the pieces T and R are nailed between ribs. When building the various sections sufficient forethought should be exercised to make certain that they may be assembled as shown in the illustration on page 262 with openings for the wedges at opposite points on the forms.

Two types of doorways are used on silos—intermittent and continuous. Which type is used is largely a matter of individual fancy as either is perfectly satisfactory. If intermittent door openings are to be used it is a good plan to provide a flat place 2 feet 4 inches wide on

Inside diameter of silo	Inner form ribs		18 gauge gal. iron 36" wide, 2 pcs.,	20 gauge gal. iron 36" wide, 8 pcs.,
	Distance A	Distance B	length of each piece. C	length of each piece.
12 ft.	4'-6¾"	4'-1½"	21'-5"	4'-8½"
14 "	5'-4"	4'-11½"	24'-7"	5'-6"
16 "	6'-1"	5'-9½"	27'-9"	6'-3"
18 "	6'-10½"	6'-7½"	30'-10½"	7'-0¾"
20 "	7'-7½"	7'-5½"	34'-0"	7'-10"

Table showing details and dimensions of reinforcement.

one section so that the door form need not be curved. Each section should be squared accurately and faced with 20-gauge galvanized sheet iron nailed in place with six-penny nails. Then the sections should be assembled in the circle which was drawn and be bolted together top and bottom with 2 x 6-inch strips. Forms should be marked so that they will always be assembled in exactly the same way.

After the forms have been assembled for the first time the projections on the ends of the ribs F and G are

cut off. This will allow the forms to collapse when the wedges are removed.

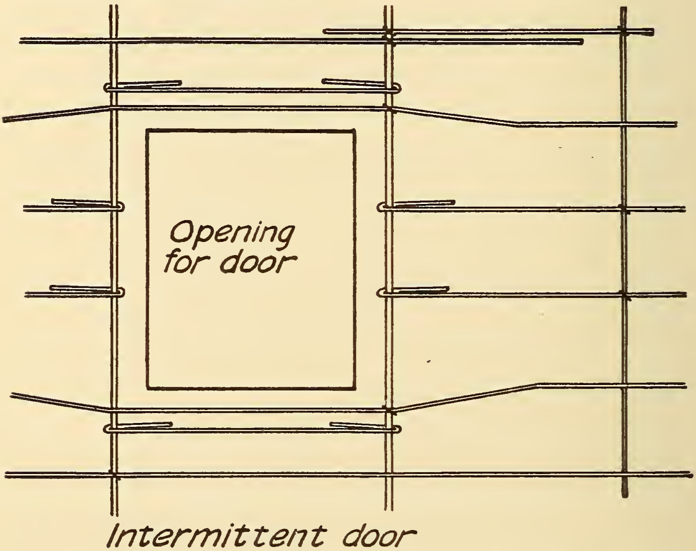
The outer forms are made of two sections of 18-gauge galvanized iron fitted with lugs for tightening and with hooks for raising as illustrated in one of the sketches.

The construction of a form for making intermittent doorway openings is shown on page 259 in the left-hand sketch. This consists merely of a frame of 2 by 6-inch lumber tapered ¼ inch on each side to make form removal easier; 2 by 2-inch pieces nailed to the frame provide recesses for the door. This form is used in alternate settings of the wall forms, thus spacing the doors about 2½ feet apart.

The continuous door frame is shown on page 259 at the right. It is made of two pieces of lumber 2 by 6 inches by 8 feet. Holes 1⅛ inches in diameter, 2 feet apart are bored in each piece with centers 2 inches from the edge. The pieces thus bored are then stripped along a line corresponding to the diameter of the holes, dividing the form into an inner and outer section to facilitate removal. Pieces of 2 by 2-inch lumber tapered slightly on one side are nailed to the inside frame. When using this form 1-inch doorway rods are placed in the holes. Cleats and spacing bars are then tacked in place to hold it upright at proper distance apart.

Arrangement of reinforcement at the doorway is illustrated in one of the sketches. The vertical rods at doorway sides should be ½ inch in diameter if the silo is of lesser capacity than 100 tons, and ⅝ inch in diameter for larger silos. When intermittent doors are used enough extra rods are placed above and below the door to compensate for the area of steel of the horizontal rods which, because of doorway openings, has been omitted at these points.

Doors for either type of doorway are made of two thicknesses of matched flooring nailed together at right angles to each other and having a layer of waterproofed building paper, such as tar paper, between them. Doors used on silos having continuous doorway openings are generally 3 feet high.



Method of placing reinforcement in silo wall where intermittent doorway openings are used.

When a silo has been filled with silage the contents subject the walls to considerable pressure. This is greatest at the bottom and greater at the bottom than usual when there is considerable liquid content held in the silo. To enable the walls to successfully resist the bursting pressure resulting from the weight of contents, the wall must be reinforced. Continuous reinforcement in the form of hoops is embedded at the center of the wall of monolithic silos. As the pressure in silos increases toward the bottom, more reinforcement must be

used in the lower portion of the structure than nearer the top. The amount of horizontal reinforcement required if rods are used is shown in the table on page 272. The following example will explain the method of determining from this table what reinforcement to use.

For an inside diameter of 14 feet the table specifies ½-inch round rods. The column at the extreme left of the table gives the distance from the top of the silo at intervals of 5 feet. Taking as an example a silo 40 feet high, run down the column to the line 35 to 40 feet, then read across the column shown under the diameter 14 feet. This gives the spacing as 12 inches which means that there must be a horizontal ring of ½-inch steel every 12 inches for the first 5 feet above the floor. For the next 5 feet the spacing changes to 14 inches and becomes greater as the top is approached. How the spacing varies may be determined by simply reading the column under 14 feet diameter at the top. This method of determining horizontal reinforcement applies to all heights and sizes of silos. If square rods are used instead of round the spacing may be increased 30 per cent. In no case, however, should spacing be greater than 24 inches.

Vertical reinforcement is needed in all monolithic silos and usually consists of ⅜-inch or ½-inch steel rods spaced 30 inches apart along a line corresponding to the center of the silo wall. Either square, square twisted or round rods may be used but for convenience in wiring horizontal reinforcement in proper position, the square twisted rod is preferable.

Various kinds of metal fabric, among them one commonly referred to as triangle mesh, may be used as silo reinforcement instead of rods, but it is necessary to know that when substituting such mesh for rods, the correct amount of metal is being used. An accompanying table

TABLE OF TRIANGLE MESH REINFORCEMENT

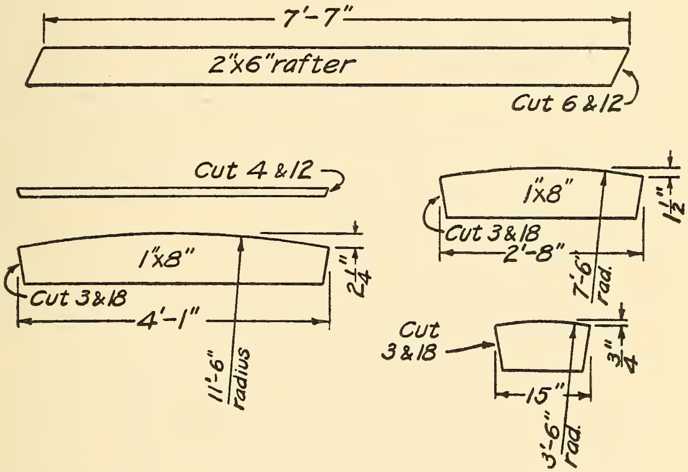
INSIDE DIAMETER OF SILO.

Distance in Feet from Top.	12 feet Layers	12 feet Style No.	14 feet Layers	14 feet Style No.	16 feet Layers	16 feet Style No.	18 feet Layers	18 feet Style No.	20 feet Layers	20 feet Style No.
0 to 15	1	093	1	093	1	093	1	093	1	093
15 " 18	1	093	1	093	1	093	1	093	1	126
18 " 21	1	093	1	093	1	126	1	126	1	126
21 " 24	1	093	1	126	1	126	1	126	2	093
24 " 27	1	093	1	126	1	126	2	093	2	093
27 " 30	1	126	1	126	2	093	2	093	2	093
30 " 33	1	126	2	093	2	093	2	093	1 each	093 and 126
33 " 36	1	126	2	093	2	093	1 each	093 and 126	1 each	093 and 126
36 " 39	2	093	2	093	2	093	1 each	093 and 126	2	126
39 " 42	2	093	2	093	1 each	093 and 126	2	126	2	126
42 " 45	2	093	1 each	093 and 126	1 each	093 and 126	2	126	2	146
45 " 48	2	093	1 each	093 and 126	2	126	2	146	2	146
48 " 50	2	093	1 each	093 and 126	2	126	2	146	2	146

Note: Style number 093 has number 6 wires spaced 4 inches apart. Style number 126 has number 4 wires spaced 4 inches apart. Style number 146 has number 3 wires spaced 4 inches apart.

will help one to determine what style and how much mesh should be used for silos of various heights and diameters.

Those fundamentals described elsewhere and pointed out as necessary to other concrete construction, apply to silo building. Definitely proportioned mixtures; clean, well graded aggregates; the correct amount of mixing



FORM FOR CONCRETE ROOF – 14 FT. SILO.

Pieces necessary for framing form for roof of 14-foot concrete silo.

water; thorough mixing; careful placing and spading in the forms to secure a good, smooth, dense surface; proper protection of the concrete after placed, are all underlying principles that must be applied if success is to follow in the monolithic concrete silo.

Among the various details that must be observed as the work of construction progresses, the following deserve particular mention.

The hoops of horizontal reinforcement should be ready and wired to the square vertical rods which are already in place. Ordinarily 12 or 14-gauge wire will answer to tie vertical and horizontal reinforcement together. It merely needs holding in position until concrete has been placed and hardened.

As steel rods come only in certain lengths, it is necessary to use more than one piece for a string of vertical reinforcement and for one of the circles or hoops of horizontal reinforcement. In such cases the rods must be spliced by lapping. In the case of ⅜ inch rods the lap should be not less than 18 inches and for ½ inch rods 2½ feet. An 18 inch lap is sufficient for the vertical reinforcement. The first ring of horizontal rods should be placed 2 inches above the silo footing and the spacing for the rods above that ring carried out as specified in the table below:

TABLE OF SPACING OF HORIZONTAL REINFORCING RODS FOR SILOS OF VARIOUS INSIDE DIAMETERS

Distance in Feet Down from Top of Silo	12′ Diameter ⅜-inch Round Rods*	14′ Diameter ½-inch Round Rods*	16′ Diameter ½-inch Round Rods*	18′ Diameter ½-inch Round Rods*	20′ Diameter ½-inch Round Rods*
Top 5 feet	24 inch	24 inch	24 inch	24 inch	24 inch
5 ft. to 10 ft.	24 "	24 "	24 "	24 "	24 "
10 " " 15 "	18 "	24 "	24 "	24 "	24 "
15 " " 20 "	16 "	24 "	18 "	18 "	16 "
20 " " 25 "	12 "	18 "	16 "	14 "	14 "
25 " " 30 "	10 "	16 "	14 "	12 "	12 "
30 " " 35 "	9 "	14 "	12 "	10 "	10 "
35 " " 40 "	8 "	12 "	10 "	9 "	8 "
40 " " 45 "	7 "	11 "	9 "	8 "	7½ "
45 " " 50 "	6½ "	10 "	8½ "	7½ "	7 "

*If square rods are used increase spacing 30 per cent but in no case should spacing be greater than 24 inches.

With reinforcement properly spaced and securely tied in position, the inside form may be set, plumbed and leveled. When concrete has been placed to ground level the outside form will have to be set. After the first

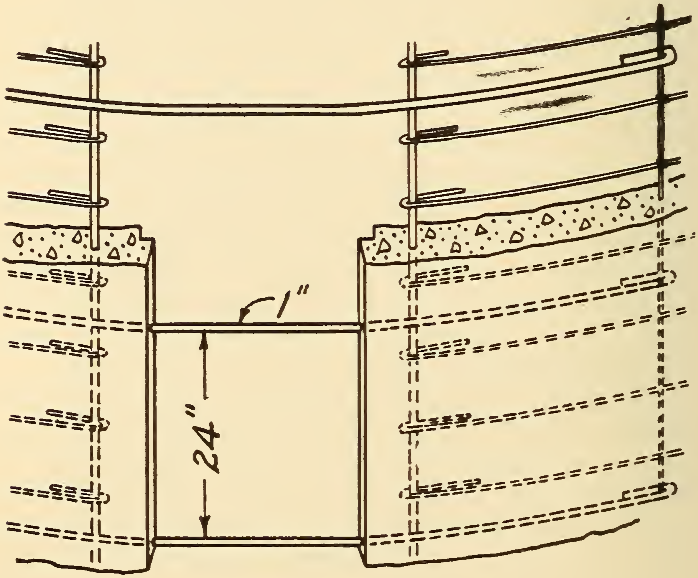
course of concrete has been placed and while the inner form is still in place on the footing, the double 2 by 4 inch uprights or plumb legs are erected through the square holes provided in the inner form. These uprights guide and support the inner form and therefore should rest solidly on the concrete floor of the silo and be carefully plumbed. They should also be plumbed after each lift to insure that the walls of the silo will be truly vertical and smooth.

Each day the outside form is raised to within 4 inches of the top of the concrete last placed. The vertical rods are spliced if necessary, the hoops or horizontal reinforcement attached to them, but only to the height of this next course. The inner form is then raised, leveled, plumbed and set in proper position, held from the outer form the proper distance by a number of spacers 6 inches long which may conveniently be made of 2 inch square blocks of wood, and which should be removed as concrete is placed up to them.

The final appearance of the silo depends principally on the care with which forms are set and plumbed and the careful spading done when the concrete is placed in the forms. Not only should spading be thorough between forms to everywhere settle the concrete so that it thoroughly surrounds and bonds to the reinforcement, but it should be thorough at the form face both inside and out so that there will be a smooth dense surface.

After concrete for each course has been placed, the top surface in the forms should be roughed so that the next day when concreting is resumed a good bond will be provided between the old and new concrete; and to prevent a construction seam through which silage juices or air may leak, the surface of the old concrete, immediately before placing new concrete, should be washed off and painted with the cement water paint frequently referred to elsewhere in similar operations.

Concrete for the upper portion of the wall can be raised in large buckets or any convenient receptacle but arrangements should be made to raise it by block and tackle and horse power because hand operation is tiring. A gasoline engine, provided it is equipped with a small drum, may conveniently be used in the hoisting operations.



Continuous door

Details of reinforcing for continuous doorway opening.

If home made forms are used like those described and illustrated, the chute over the doors is built after the wall is completed. The commercial steel silo forms used by silo contractors permit building the chute when the wall is built and monolithic with it.

Forms for door openings should be ready when concreting of walls is commenced and these forms should

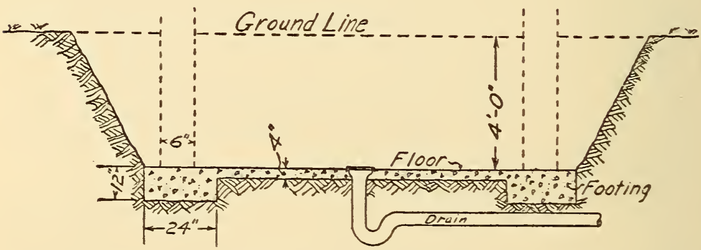
be oil soaked or thoroughly wet down so that they can be more readily removed from the concrete after it has hardened. Careful spading of concrete around door forms should be done to produce a smooth surface so that when the door is fitted it will close tight. It is customary to paint the inside wall surface with a cement water paint as rapidly as forms are raised. If done at this time it will adhere better to the concrete and when the whole inside surface has been painted this way slight irregularities of surface due to carelessness or neglect in spading the concrete, or because of a leak in the forms that has carried away water and cement, will be covered up.

While not necessary to do so, the exterior of the silo can be given a more uniform appearance by being painted in the same manner, but before doing this all holes that may appear on the surface as a result of stone pockets due to improper or careless spading of concrete should be cleaned out by brushing with a stiff wire brush, and be filled with a 1:2½ cement mortar.

One of the particular advantages of the concrete silo is not enjoyed to the fullest measure unless the structure is made fireproof throughout by finishing it with a concrete roof. To give this finishing touch a more attractive appearance, forms should be so built that the roof will have a slight overhang, forming a cornice. The drawing of the roof form and its details shows how to provide for this. Brackets of ¼ by 2 inch scrap iron are bolted to the top of the outer form at intervals of about 5 feet. The bottom of this cornice mold is made of a short piece of 2 by 6 inch lumber cut to the curvature of the silo. The side of the mold is a 1 by 6 inch piece nailed to the bottom pieces and bent to the curve of the cornice. When finishing the top of the silo wall, an offset 2 inches wide and 1 inch deep should be left on the inside to support the lower end of the form boards. Remove the

inner wall forms over the top of the silo and build a frame work of eight rafters and eight sets of headers as shown in the sketch. The lower ends of alternate rafters should be tied together by 1 by 4 inch boards. This frame work is covered by 1 by 12 inch boards cut diagonally and laid with the wide ends at the base of the roof.

A frame for the filling window should also be made like the frame used to provide openings for the intermittent doors. One-inch lumber will do for this. This opening should be large enough to receive a sash containing four 10 by 12 inch lights. In other words the opening should be 2 by 2 feet 5 inches.



Method of placing concrete floor and footing as well as drain and also showing how excavation must be made when earth is not sufficiently firm to be self-sustaining.

Place the reinforcement in position, cover the entire form, including the cornice form, with strips of woven wire mesh reinforcement and with rods according to the size of the silo. For a silo 16 feet in diameter and less a ½ inch square rod with ends securely hooked together is placed around the base of the roof. For silos larger than 16 feet in diameter two of these rods should be used. The ends of the vertical rods projecting from the wall are bent over and buried in the concrete of the roof. A ⅜ inch or ½ inch rod is placed entirely around the filling window opening.

Concrete for the roof is mixed 1:2:3. The roof should be of an average thickness not less than 3 inches.

The chute is fastened to the silo wall so as to enclose the doorways. It not only serves to protect from the weather and to prevent the scattering of silage as it is thrown down for feeding but if built of concrete as it should be, will protect the doors from fire. A chute 2½ feet square inside is a convenient size. Where home made forms are used the chute is most easily built after the silo walls have been completed. When these are built, however, ⅜ inch rods 2 feet long are placed in the walls at each side of the doorway 2 feet apart vertically. They are hooked around the wall reinforcement and are bent up so they can be laid next to the outer form. When the form is removed these rods lying at the surface of the concrete are bent straight so as to project into the chute and tied securely to the silo. Wood forms may be used for building the chute and the concrete should be reinforced with ⅜ inch rods 2 feet apart horizontally and vertically.

In some silos having continuous doors, the heavy bars extending across the doorway openings are used instead of a special ladder. It is better, however, to provide a ladder on the inside of the chute. In a monolithic concrete chute this can be done by setting U shaped rings of ½ inch iron in the holes left in the concrete, these holes being formed by tapered wooden plugs placed in the wood forms where the holes are desired.

The following table which is based on a proportion of 1:2½:4 for wall and 1:2½:5 for foundation and footing, shows the quantity of concrete materials required for monolithic silos of various types, exclusive of roof.

QUANTITY OF CONCRETE MATERIALS FOR MONOLITHIC SILOS OF VARIOUS DIAMETERS

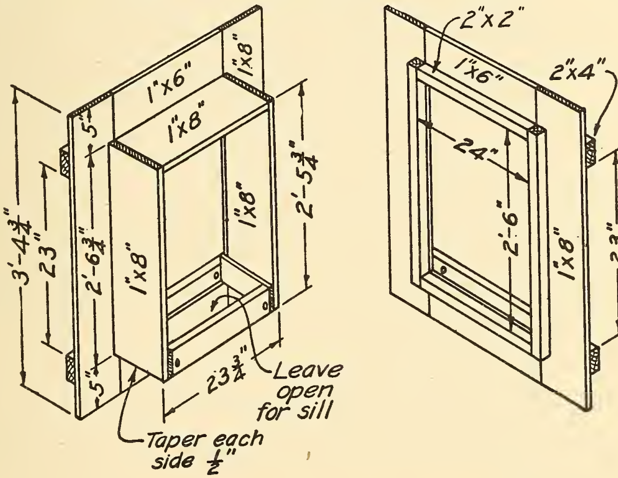
These figures include footings and floor but not roof. Walls 6 inches thick. Continuous doors 2 feet wide. Figures are for barrels of cement and cubic yards of sand and pebbles:

Inside	For Silo 30 Feet High			For Each Additional 5 Feet in Height		
Diam.	Cement	Sand	Pebbles or Stone	Cement	Sand	Pebbles or Stone
Feet	Bbl.	Cu. Yd.	Cu. Yd.	Bbl.	Cu. Yd.	Cu. Yd.
12	35	13	21.5	4.8	1.8	2.9
14	40.5	15	25	5.6	2.1	3.4
16	47	17.3	28.7	6.4	2.4	3.8
18	53	19.6	32.6	7.3	2.7	4.3
20	59	22	36.5	8.1	3.0	4.8

Frequently those desiring to build their own monolithic concrete silos have found it possible to provide themselves with commercial forms such as used by the rural contractor by interesting a number of their neighbors to join them in purchasing such equipment, and although the forms illustrated and described will result in a perfect silo if properly used, the commercial forms will be found much more convenient and satisfactory. They are built of sheet steel braced with angle iron and in other ways specially constructed so as to be rigid and easily handled. All commercial forms have certain general principles in common. They consist of rigid sheet metal properly stiffened, made in sections, each section being a part of a complete circle corresponding to the inner and outer circumference of the silo. These sections are fitted with easily adjustable clamps to permit holding the sections firmly together.

Because of their rigidity and accurate fit, the assembled form is easy to manipulate in raising and gives a true even wall surface.

When several farmers combine to purchase forms as suggested, the unit cost to each does not materially affect the cost of the finished silo. In fact, where eight or ten silos are to be built with community owned forms as suggested, it is likely that the form cost of each silo will be less than the cost of the home made form built especially to serve one usage. After the community owned forms have served the purpose of those for whom they were originally obtained, they being durable and



Forms for arranging doorway openings.

long lived if properly handled, may be rented to others equally desirous of using them and thus may eventually be made to return their entire first cost.

Concrete Block Silos. Block silos, as the name implies, are built of concrete block similar to those used in other concrete block construction with the exception, however, that the block are molded in special machines whereby they are given a form corresponding to part of the circumference of a circle so that when laid a course completes a circle.

Distance from top of Silo	Diameter of silo (inside)				
	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.
Feet	1	1	1	1	1
	0	0	0	0	0
2	1	1	1	1	1
	0	0	0	0	0
	1	1	1	1	1
4	0	0	0	0	0
	1	1	1	1	1
	0	0	0	0	0
6	1	1	1	1	1
	0	0	0	1	1
	1	1	1	1	1
8	0	0	1	1	1
	1	1	1	1	1
	0	1	1	1	1
10	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
12	1	1	1	1	1
	1	1	1	1	2
	1	1	1	2	1
14	1	1	1	1	2
	1	1	2	2	1
	1	1	1	1	2
16	1	1	2	2	1
	1	2	1	1	2
	1	1	2	2	1
18	1	2	1	1	2
	1	1	2	2	2
	1	2	1	1	2
20	1	1	2	2	2
	2	2	1	2	2
	1	1	2	2	2
22	2	2	2	2	2
	1	1	2	2	2
	2	2	2	2	2
24	1	1	2	2	2
	2	2	2	2	1
	1	2	2	2	1
26	2	2	2	2	1
	1	2	2	1	2
	2	2	2	1	1
28	1	2	2	1	1
	2	2	2	1	2
	1	2	2	2	1
30	2	2	2	1	1
	2	2	1	1	2
	2	2	1	2	1
32	2	2	1	1	1
	2	2	2	1	2
	2	2	1	2	1
34	2	2	1	1	1
	2	1	2	1	2
	2	1	1	2	1
36	2	1	1	1	2
	2	2	2	1	1
	2	1	1	2	2
38	2	1	1	1	2
	2	2	2	2	1
	2	1	1	1	2
40	2	1	1	2	2

Mortar joints 8 inches apart.

No. 3 wires above this line.

$\frac{3}{8}$ inch round rods below this line.

Table showing method of determining required quantity and spacing of reinforcement.

The details of block making given elsewhere apply to the making of silo block. These block can be home made but usually the limited use made of them by the farmer, say for one or two silos, does not warrant the purchase of a machine to make them so it is generally best to buy block of a nearby cement products plant. Such block are more likely to be uniform and well made and insure a more satisfactory job.

Excavation, floor and footing for the concrete block silo are exactly described for the monolithic silo. As a matter of fact, all well built silos, regardless of the materials used, must depend on concrete for the floor, footing and foundation wall.

After the floor and footing is twenty-four hours or more old, the first course of block may be laid on it. The line along which to lay this can be marked on the top of the footing by a sweep just as the circumference for the monolithic silo excavation or wall is marked out. The first course of block should be laid carefully to line, bedded in about ½ inch of 1:2 or 1:2½ cement mortar. In each course the block are so arranged that they break joints. An even number of block or half block complete the circle. As the block are laid the wall should be frequently plumbed to insure that it is being laid up truly vertical.

The average home builder is not so competent at masonry work as he may be with concrete or other farm building or repair, so it will generally be found desirable to have a brick mason lay the block. In this way a more attractive structure can be obtained, the work will be done more quickly and, the chances are, at no greater expense.

Block silos also must be reinforced. Provision for reinforcement, which is confined to horizontal hoops, is usually made by casting a groove in the upper face of

the block. Usually ¼ inch rod or No. 3 wire is used as reinforcement, laid in the mortar joints. The table shows the quantity of this reinforcement necessary at each joint. As in monolithic silos, the pressure is greater at the bottom; therefore two strands of wire are not sufficient at the bottom of a large block silo, so a ⅜ inch round rod is specified for the lower portion, that is, in each joint of the lower 6 feet of the wall. From that point upward ¼ inch wire or rods are used. This wire usually comes in coils and must be partly straightened before using to make it convenient to lay in the mortar joint.

This can be done by pulling it from the coil through a piece of ¾ inch gas pipe about 30 inches long, this being curved slightly in a direction reverse to that desired to straighten the wire.

Intermittent doors with concrete door frames are to be preferred for a block silo. The interior of the block silo may be given a coat of cement water paint like that used on the monolithic silo. The roof and chute may be built in about the same manner except that the chute instead of being monolithic concrete is usually built of block specially made for this purpose.

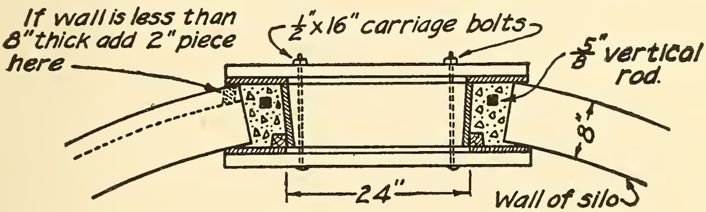
Cement Stave Silos. Both monolithic and concrete block silos meet all requirements of the ideal silo. These requirements are also met by the cement stave silo, one of the newer types of concrete silos but one that is coming rapidly into popular favor. This silo is known as the cement stave silo because of the units of which it is built. These are slabs of concrete 2½ to 3 inches thick, 10 to 12 inches wide and from 28 to 30 inches long, depending upon the particular type or stave of unit.

When used to lay up the wall the staves are set on edge and usually are made so one stave interlocks with adjoining ones. There is some difference in methods prevailing among the different stave manufacturers or

systems of building stave silos as to how staves join in the wall, but in the main these slight differences are not of great consequence since all types of cement staves produce a first class silo and choice of any type is therefore largely a matter of personal fancy.

Like the other types of concrete silos described, the cement stave silo is wind-proof, rot-proof and fireproof. The weight of concrete stave silos makes them particularly stable even when empty. There is no known instance of any concrete stave silo having blown down.

Foundation construction for the cement stave silo is like that already described for monolithic and block silos. Excavation, foundation and floor having been



Sketch showing detils of doorway construction.

made, the first course of staves is set upon the foundation, formed of full and part length staves alternating. This starts the breaking of joints which is maintained to the top row, this row being finished exactly as the start was made, namely with full and part length staves. As each course of staves is placed in position, a steel band or hoop is put on and tightened. When the structure is finished more hoops must be added on the lower part of the silo to insure that spacing is closer there than at the top because of the added pressure on this portion of the structure walls. When all of the staves have been set, the hoops are tightened to take up any slack.

The inside wall of the cement stave silo is usually painted with a cement water paint. This fills the small

water pockets on the surface of the foundation and seals the seams between adjoining staves and gives a smooth, even, watertight surface.

Cement stave silos can be built with continuous doorways from top to bottom without weakening the structure. Specially designed door frames of concrete or steel are used and both types have given excellent satisfaction. Door openings are usually about 24 by 36 inches which allows plenty of room to remove silage. Convenient ladder steps are provided and doors fit tight to door frames to keep out air.

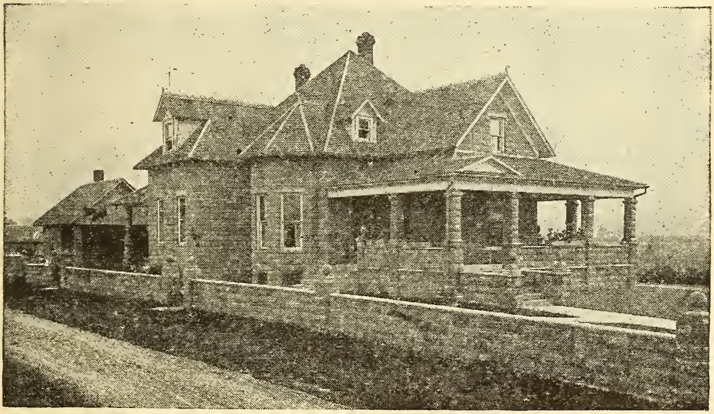
Cement stave silos, like monolithic and block silos, should be equipped with a chute. This can be built of staves similar to those used in building silo walls.

One particular advantage of the cement stave silo which has been responsible for its increase in popularity in the last two years or more is the fact that it can be very quickly erected. Speed of construction is necessarily limited on monolithic silos because forms can be set but once every twenty-four hours. This limits the amount of work that can be done to one lift of forms. The cement stave silo can be built in less time than any other type of masonry silo. An average sized one is usually built complete in three days. It is not recommended that any one attempt to erect his own cement stave silo. Many cement product plants are now specializing in the manufacturing of cement silo staves and in addition thereto usually contract to erect the silo. As a rule the cement stave silo is equipped with a galvanized metal roof.

NOTE: The author is indebted to the Portland Cement association for the drawings and most of the data in this section on Silos.

HOW CONCRETE MEETS HOME REQUIREMENTS

Before the intending home worker starts to build he usually has given considerable thought to the various things that he would like to incorporate in his home. If he has done this he has probably formed a mental picture of a structure that, to him at least, represents the ideal. The home or house must be attractive both inside and out. It must make possible comforts which he wants and en-



Concrete block farmhouse and concrete block wall enclosing the house grounds.

joys. It must not be too costly; it must express the builder's ideas of type of architecture; and if it does all these things and has these good points it will prove a source of satisfaction to the builder and owner and will likely prove a good investment. Having all of these recognized good points will make the house possessing them attractive to some one else, which is desirable if through necessity the owner is compelled at some time to sell it.

What a home costs in the first instance is not its total cost. Expenditures for insurance, painting and other maintenance and repair represent a part of the investment and should be considered as part of the cost. How much the total of these additional items can be reduced depends on how well built the house is, and particularly how nearly it meets the idea of permanence.

In order to appreciate the deficiencies of existing houses, whether in the country, small town or city, we must remember that fireproof construction has been the exception

An example of concrete architecture in which the monotony of the concrete surface is relieved by combining with brick.

rather than the rule, particularly in the home, and this is due almost entirely to a mistaken idea that the cost of building fire-safe and for permanence is beyond the average home builder's ability to meet. Foundations are usually built as nearly permanent as modern knowledge and skill can make them, yet when the foundation is finished the house builder often ends with a firetrap.

The past two or three years have seen greater use of concrete in home building than perhaps any ten or twenty years preceding. There are a number of ways in which

concrete can be used to secure desirable degrees of fire-safeness in a house. One of these consists of erecting a structural frame of steel to which metal, lath or fabric is fastened and over which there is applied Portland cement stucco. This subject has been covered in another section so will not be repeated here.

In steel frame construction metal lath or fabric is also attached to the frame on the interior, enabling interior plastering to be applied and thus resulting in thorough fire-proofing of the steel frame. Partitions may be of steel frame and metal like the exterior walls or they may be of hollow cement tile, clay tile, concrete brick or concrete block. Floors and roofs may be solid slabs of reinforced concrete or may be concrete tile or reinforced monolithic concrete. Metal lath is attached to the underside of beams to receive plaster of ceilings.

Another method consists of making walls of concrete block or similar units, with partitions, floor and roof as just described. Concrete block walls may be solid or hollow. The same applies to partitions.

In another system walls, partitions, floors and roofs may be monolithic concrete throughout, reinforced if necessary. Such houses are built by depositing the concrete mixture into previously erected forms in exactly the same manner as would be used to build any other structure on the farm.

Still another system of which many types have been developed is what is known as the unit system. In each so-called unit system the fundamental principles involve using precast reinforced units. Slabs are then set up and fixed into position. The advantage of such system is that designs may be largely standardized without sacrifice to variety from an architectural standpoint. Walls, partitions, floors and roofs may be solid or hollow, and also may be precast and assembled at the site of the structure.

The concrete house, regardless of the system employed to build it has a measure of stability not secured by any other building material. Monolithic concrete makes the house like one solid stone. It will grow stronger with age. Masonry however, well laid, is a collection of small units and cannot be expected to have anywhere near the same stability. For this reason the order of preference for the type of construction used in concrete houses may be first

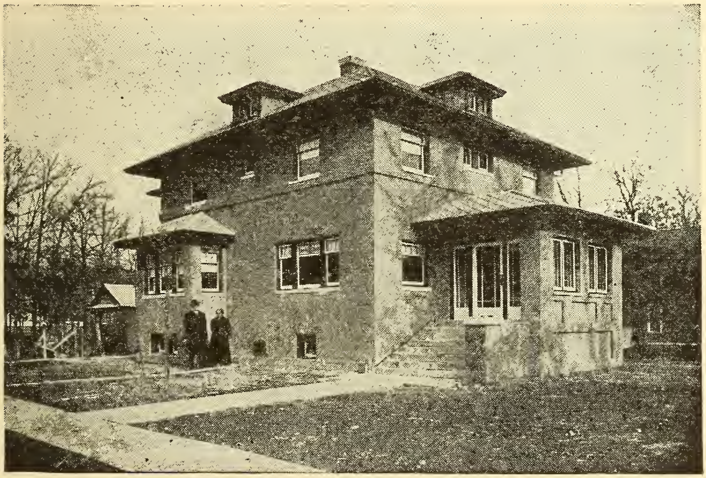
Concrete house with molded stone courses intended to resemble this class of masonry.

monolithic concrete construction, then some one of the unit types, preference being given to the construction involving the largest units.

One should not overlook the distinctive merits of concrete block because these units are easy to obtain of high class quality, and workmen can be found in any community who can carry out the plans.

Concrete provides a sure barrier to the entrance of rats and mice, and because of the natural density of the material does not afford permanent lodging places for disease germs and vermin.

The ideal home is one in which a comfortable temperature can be maintained, summer or winter, one requiring relatively little effort to keep warm during cold weather. No other material makes these ends possible in so great a degree as concrete. The adaptability of the material is such as to make it possible to follow any admired type of architecture, in fact the artistic possibilities of concrete have been given far too little appreciation. Monotony of plain



An example of stucco construction.

walls can be relieved by careful planning of forms to introduce raised or depressed medallions, moldings and other simple embellishments that give decorative finish in keeping with the structure or the material. If block are used a type should be chosen that does not have a face attempting to imitate rough cut stone. Concrete being a distinctive building material and possessing within itself unusual merits and possibilities, should not be used to discredit either itself or another building material by trying to imitate something that it is not.

There are many types of concrete block on the market which are dependable and the use of which produce economical construction. The particular advantage of block is that with some of the approved types it is easier to secure hollow wall construction than by any other use of concrete and the advantage of hollow wall construction is that the dead-air space thus introduced in the wall insulates the interior of the house from extremes of outside temperature.

The thickness of concrete walls for two-story house

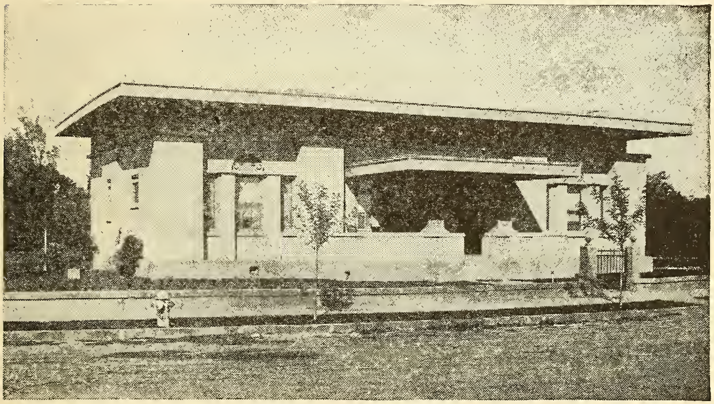
Monolithic concrete bungalow with stucco finish.

would ordinarily be 12 inches for the lower floor and 8 inches for the second floor. These dimensions may, however, be varied under certain conditions, such as the size of the house, loads which must be carried by the walls, and other considerations which would necessarily enter into the widely varying possibilities of concrete design.

The matter of reinforcing concrete walls or other parts of a structure has been greatly simplified in late years by the introduction of various patented forms of metal fabric or wire lath.

There are many possible ways of using concrete for floors in the concrete house and one will not realize the full benefits of the construction material unless it is used everywhere it can be.

In cold climates walls should either be double, or when plastering is done furring should be so placed that the top coat is brought out a sufficient distance from the concrete to introduce a dead-air space for insulation. If this is not done there will be dampness on the concrete wall due not to



An example of the architectural possibilities of concrete in home building.

moisture passing through the concrete but to condensation of moisture from the interior atmosphere when it comes in contact with the relatively colder wall surface. An example of this can be found in the pitcher of ice-water brought into the warm room. The pitcher does not leak but immediately condensation from interior atmosphere forms on the cold surface of the pitcher.

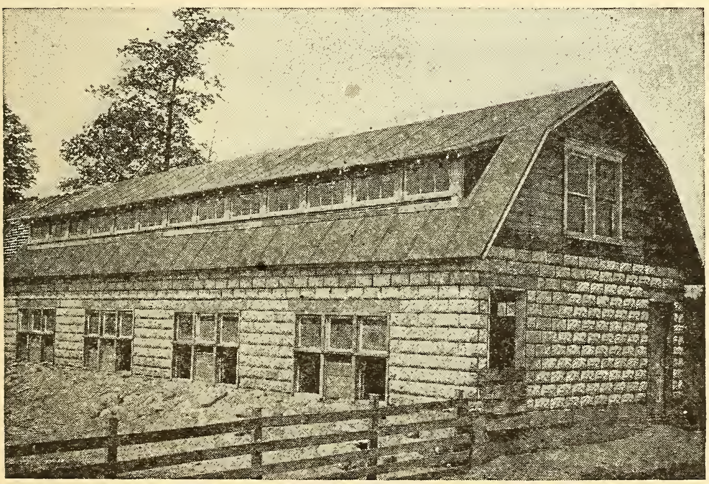
An important detail when considering fire-safe construction of any house is the stairway. In case of fire, stairways serve as flues and help fire to spread. Stairs can be built of reinforced monolithic concrete or of precast units properly assembled. Either system is effective. Interior floors

can be made very attractive by proper surface finish. If they are built of two course construction as is usual in residences, then the top or wearing course can be composed of a mixture of either gray or white cement and selected aggregates such as markle or granite chips, and when the concrete has hardened the surface can be ground down by using one of the several types of rotary floor polishing machines, thus exposing the aggregates and giving them a polish. Exterior finish of concrete can be modified in many ways as described elsewhere under concrete surface finish.

This discussion of concrete for house building has not been presented with the expectation that the home worker will aspire to build his own house but rather to acquaint him with the possibility and desirability of this material in home building. Concrete means the elimination of insurance on the building and doing away with the cost of upkeep and repairs. For this reason it is important to learn that what seems cheapest in the beginning is likely to prove the most expensive in the end. In from five to eight years after the average house has been built cost of repairs becomes an important item, and long before that time the concrete house from its economy in freedom of maintenance, fire-safeness and other desirable qualities will have proved itself not only the better investment from the investment standpoint but actually cheaper.

CONCRETE FOR THE HOGHOUSE

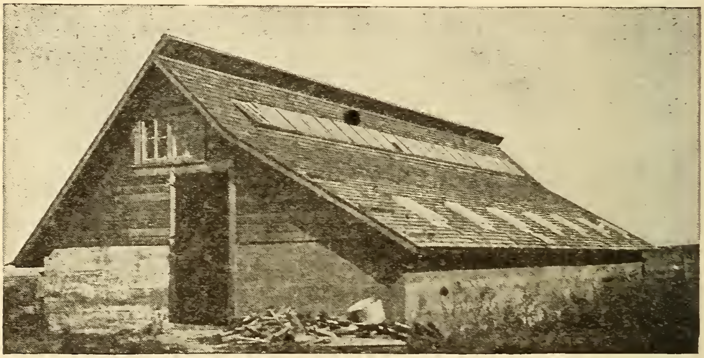
Hogs respond just as quickly to good treatment—to clean, healthful, sanitary quarters—as do any other live stock. In fact they are very easily affected by extremes of heat and cold and their quarters should be planned and built with this fact in mind. Especially do the newly farrowed pigs require necessary protection from the elements. Without warm quarters they cannot be expected to do well. They must also have dry quarters, abundance of light, which means sunlight, and must have housing under conditions that permit efficient ventilation. They must have an abundance of pure air. Sanitation is all important and nothing else can be maintained in such a thoroughly sanitary condition as concrete construction. Concrete walls and floors are



Attractive concrete block hog house.

without cracks and crevices in which filth can lodge, and such surfaces are easily disinfected when necessary. Permanence comes in for consideration nowadays and concrete secures this end. Reasonable first cost is also met by concrete, and ultimate cheapness results from the fact that the annual maintenance expenditures that are necessary to wood structures are done away with entirely.

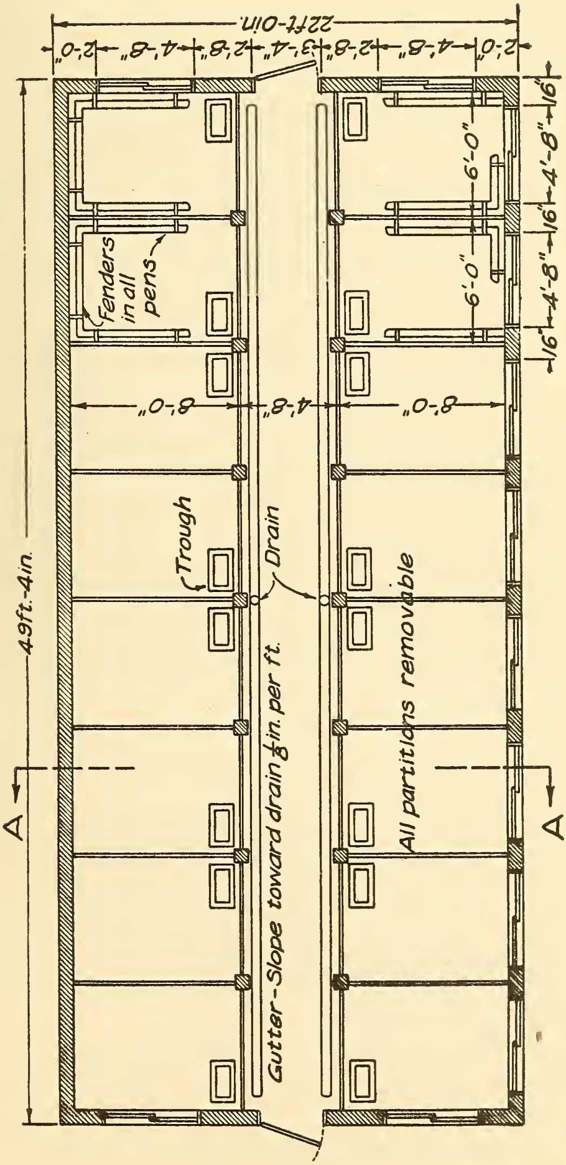
An accompanying design points out the possibility of one other feature which is too often overlooked in planning



Monolithic concrete hog house. Notice windows in the roof so placed as to insure sunlight in both rows of pens.

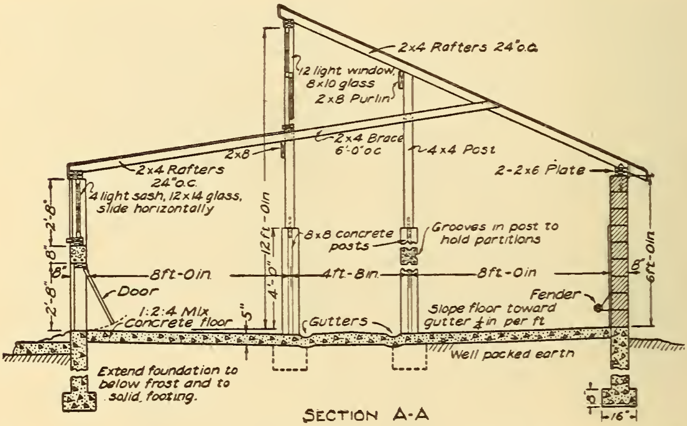
farm structures, that is, a reasonable degree of attractiveness. There is no longer the necessity of erecting ugly or at least unattractive farm structures since that wonderfully adaptable material, concrete, is limited in its possibilities only by the ingenuity of the man who is using it. A little forethought in the way of planning a pleasing exterior for any building is well repaid through the years which one must look at and use it.

The site for the hoghouse should be carefully chosen. The building should be located so that it will be convenient to a suitable hog lot or range and convenient also for feeding. Other chapters have discussed some of the necessary



Suggested plan for concrete hog house.

adjuncts to hog raising such as hog wallows and feeding floors. These will not be touched upon in this chapter. It goes without saying that a modern hoghouse should be served by such appointments. The site should be chosen with particular reference to good drainage. If good natural drainage does not exist, then the area which is to be used for the hoghouse should be prepared for the purpose. The entire site which will eventually be concrete floored should be prepared for the purpose by digging off all vegetation



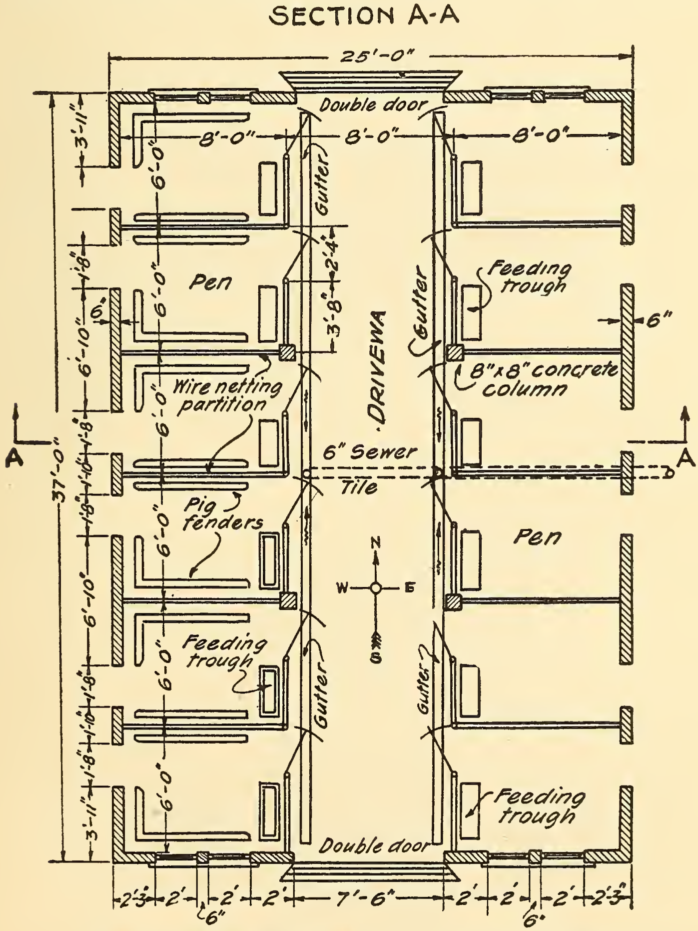
Detailed cross section of the structure suggested in the preceding plan.

and refuse matter and preparing an 8 or 10-inch subbase of well compacted clean gravel containing but little sand.

Footings for the walls should extend a sufficient distance below ground level to prevent possible disturbance from frost. Before walls have been concreted, provision must be made to insert drains that will serve to keep the subbase for the floor well drained.

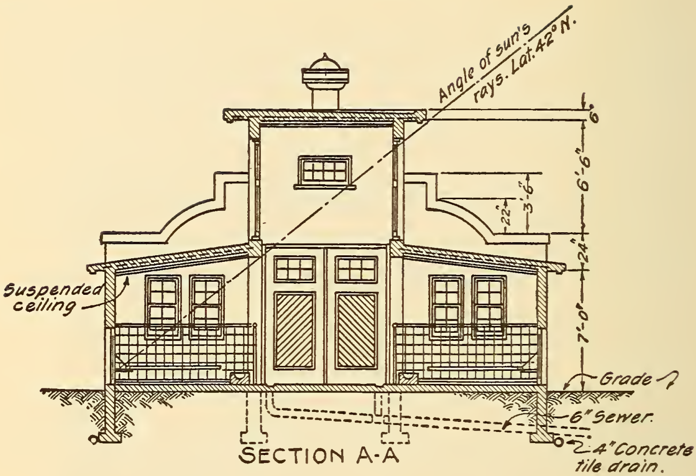
The house should face south. The upper tier of windows will admit the sunlight to the back, or north side pens. Gates and panels at the front of pens are removable, this being provided for by a flange set into the concrete floor attached

by bolts to another flange which in turn has pipe threaded into it, thus forming posts to which panels and gates may be hung. Fenders in the pens are attached in a similar manner



Plan of concrete hoghouse with double row of pens.

and are built of 2-inch galvanized pipe, threaded into the flanges and connected up with elbows. Two pens, one at each end, or one pen, if that will provide sufficient accom-

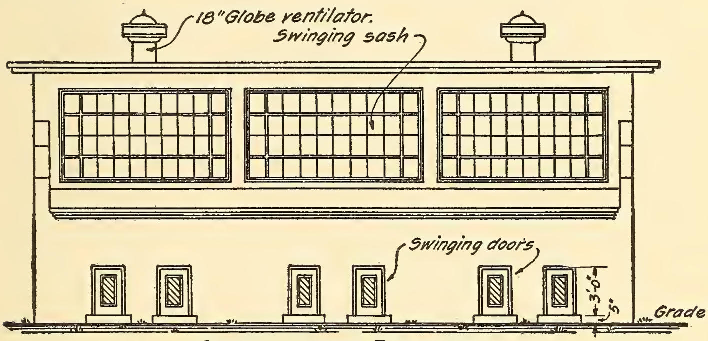


Part section of concrete hoghouse showing how the design meets requirements as to permitting sun to reach both rows of pens.

Suggested end elevation of concrete hoghouse.

modation, can be entirely concrete walled and made to serve as a feed room, or if two are used for this purpose, one may contain the feed cooker.

While concrete floors are not cold for stock if the animals are sufficiently bedded, hogs are a little more difficult to provide for in this way than other animals, since their tendencies are to disturb a bed prepared for them, thus they would lie on the concrete surface a greater portion of the time. It is therefore well to build a removable slat floor in one corner or at one side of the pens for a bed.

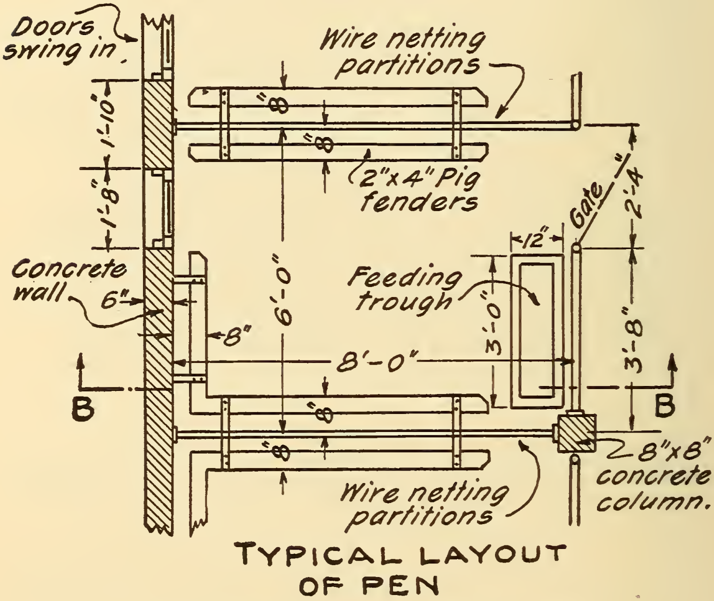


Suggested side elevation of concrete hoghouse.

In ordinary weather proper manipulation of the windows will secure necessary ventilation without exposing the animals to drafts. In cold climates or during extreme cold spells it is usually advisable to provide some means for heating the hoghouse so that a proper degree of warmth may be maintained. One or two small oil heating stoves will usually be found sufficient under most cases where artificial heat is necessary.

A concrete driveway through the center of the hoghouse permits entrance of team and wagon so that feed can readily be hauled in or the wagon used when desired to clean out pens. Pen floors should be sloped slightly toward the

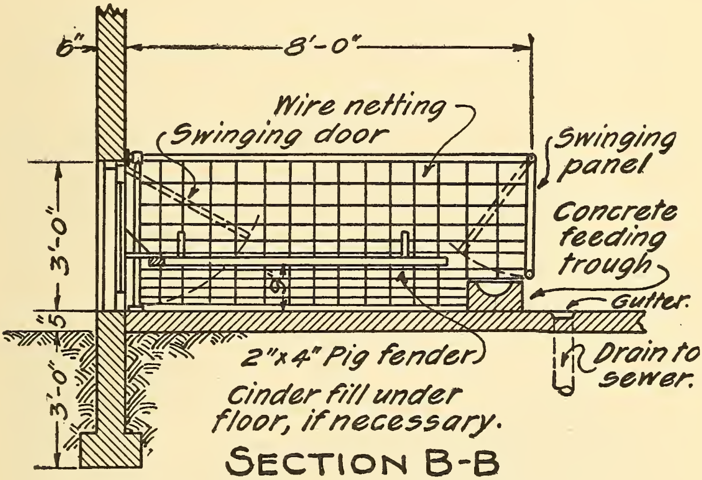
gutters at each side of the driveway and the driveway in turn sloped from its center toward the gutters so that when washing pens and driveway, the liquids will be conveyed to the drain, this leading to a manure pit where all liquid fertilizer may be conserved.



Enlarged details of various features of pen.

On the average farm the hoghouse is the poorest or most neglected building of the farm group, and the worst adapted to the purpose for which it is used. Good barns and good other buildings may be seen on many farms but the hoghouse is generally given scant consideration. It is just as good economy to put up hoghouses that will be free from maintenance and that will help the hogs to help you make money as it is to put up good buildings for any other farm use.

No piggery is fit for its purpose unless there is direct sunshine on the floor of every pen, dryness, warmth, fresh air, freedom from draughts, and sanitation. No one can afford for any purpose, a building so expensive that interest and depreciation will eat up its usefulness, and such a

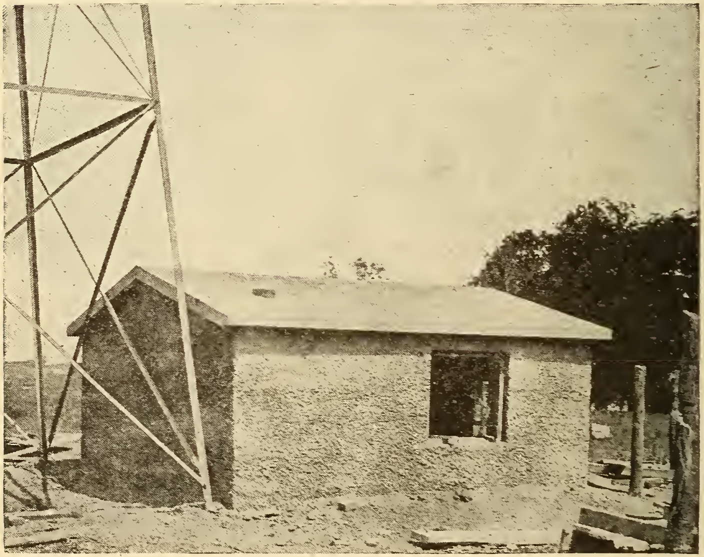


Details of fender and typical floor section.

building may quite readily be built by the misguided use of impermanent materials and unnecessary frills that will make the burden of its upkeep soon prove it the most expensive structure in the end. The first cost of concrete is the only one. The maintenance, sanitation and all other good qualities are built into it at the time it is planned and constructed, if forethought and good workmanship are always on the job.

CONCRETE FOR THE FARM DAIRY HOUSE

National health requires that milk and cream be produced under the strictest sanitary surroundings, that they be quickly cooled to the required temperature and kept free from contaminating influences until marketed. Economy

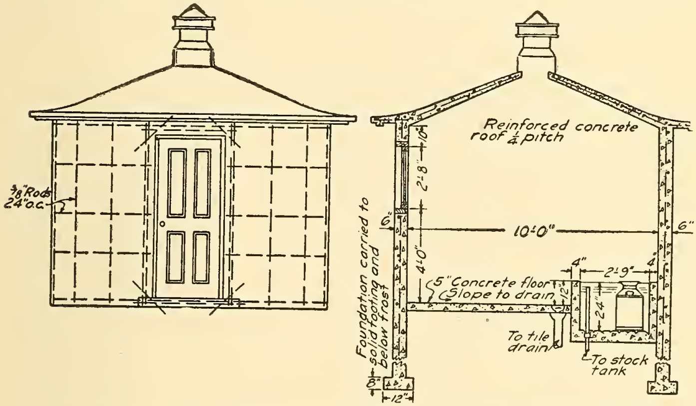


Monolithic concrete milk-house.

requires that labor-saving equipment be used and that permanent, fireproof, rat and vermin-proof, sanitary materials be used in the construction of the dairy house. For esthetic reasons a material must be selected harmonizing with the neighboring buildings on the farm. Concrete has been found especially suited to the strictest dairy house requirements of every section of the country. The accompanying plans,

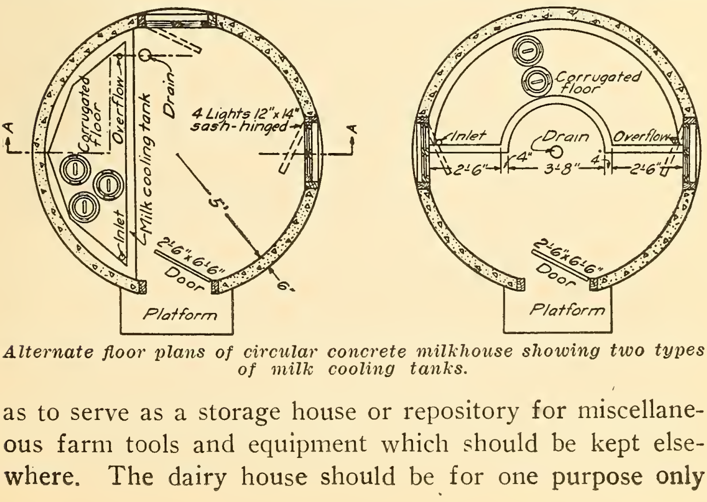
showing a concrete dairy house, represents a structure adapted to the average farm.

The size of the dairy house is largely dependent on the



Section and elevation of circular concrete milk cooling house showing position of reinforcement and other details.

size of the herd, whether whole milk or only cream is saved, frequency of trips to market, and possibly other conditions. One should avoid making the house so large

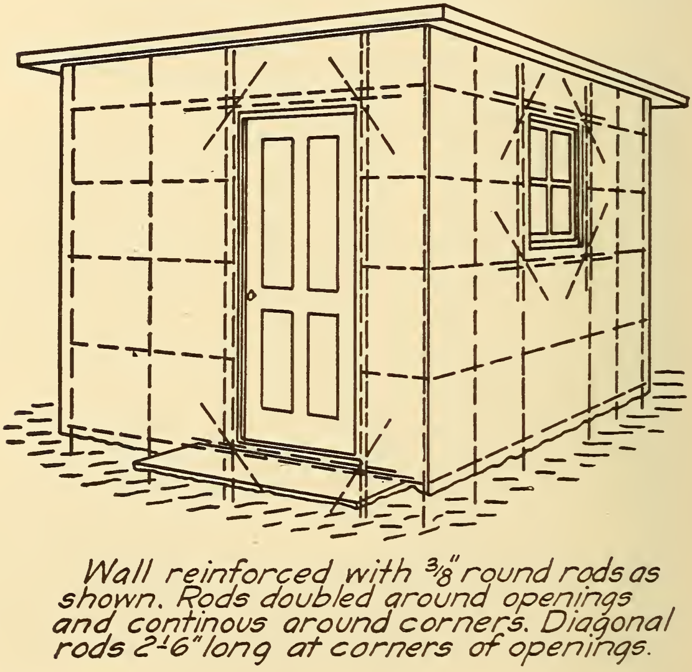


Alternate floor plans of circular concrete milkhouse showing two types of milk cooling tanks.

as to serve as a storage house or repository for miscellaneous farm tools and equipment which should be kept elsewhere. The dairy house should be for one purpose only

and extra size should be for possible dairy requirements only.

The dairy house should be easy of access from the house, the barn and the icehouse, as well as close to the driveway, for easy loading on the wagons for town trips.

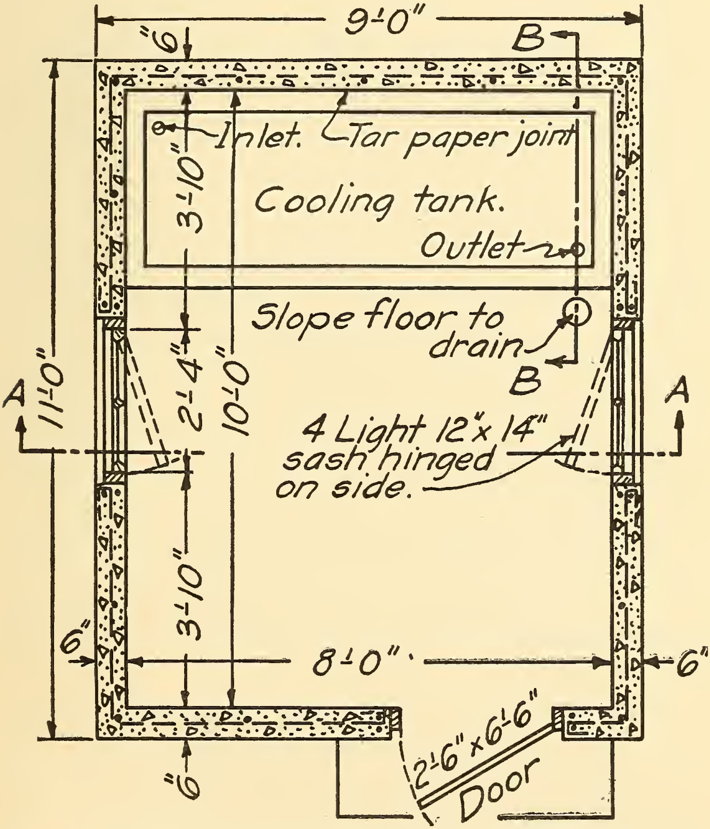


Perspective elevation of rectangular milk cooling tank, illustrating position and method of placing reinforcement.

The site should be high to provide drainage for sanitation. A shady spot is an advantage in summer, although the sterilizing effect of sunshine should not be overlooked.

Good drainage is necessary. To the natural drainage of the soil must be added the waste from the cooling tank as well as the waste from the floor drain. Where considerable water is used for cooling, supplied either from

springs by gravity or from wells by pumping, a liberal sized drain must be laid to a suitable outlet. The frequent washing down which the entire interior of the house should receive makes adequate drainage imperative.

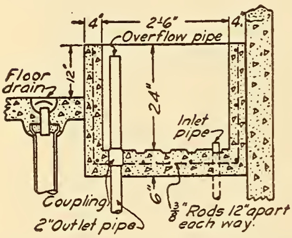


Plan of rectangular concrete milk cooling house showing location of milk cooling tank.

Good circulation of air is necessary in the dairy house, and this should not be left entirely to a chance opening of the door or windows. A metal ventilator may be built in the roof and a constant changing of air can thus be main-

tained. During the warmer months the windows will usually be left open, and under these conditions the openings must be protected with screens, preferably non-rusting, to keep out flies and other insects.

Foundations for the dairy building must go down to solid soil and below the possible action of frost. The footings should all be down to the same level all around and unless the soil is suitable for a foundation for the tank and floor, it should be excavated and filled in with gravel or clean cinders well compacted.



Cross section through concrete milk cooling tank showing inlet and overfloor pipes and floor drain.

Forms for the roof must be solidly supported, for the entire weight of the wet concrete must be maintained until the concrete hardens and becomes self-supporting. The roof forms should be blocked up with wedges so that when taking them down the forms can be released slowly.

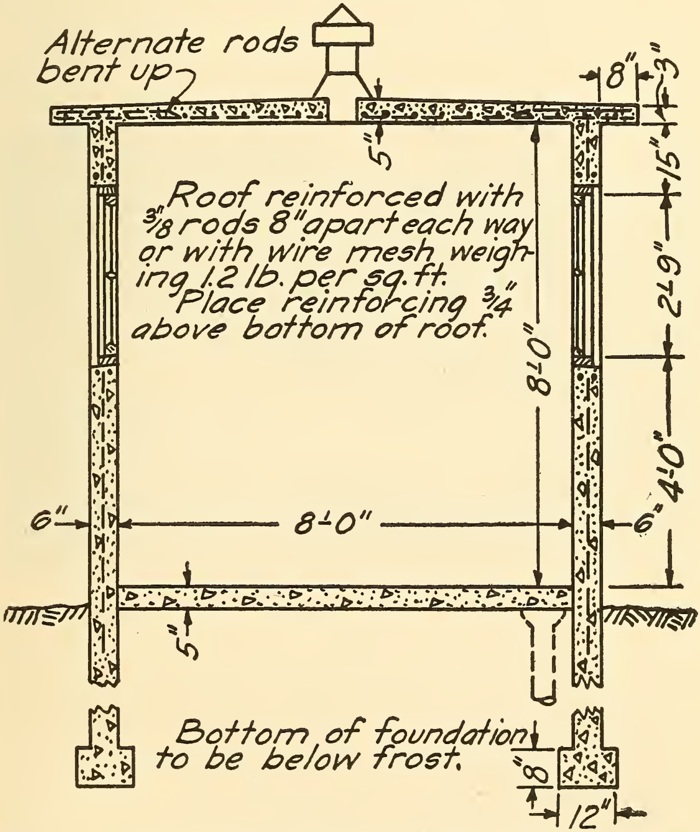
Before filling the tank forms, one must be sure the inlet and outlet pipes are properly placed. Note that the waste pipe has a coupling with the top flush with the floor of the tank. This is to permit the removal of the overflow pipe, to drain and flush out the tank.

After the walls, roof and tank are completed, the floor may be laid. While no forms are needed for this, care must be used to give the floor a slight pitch to the drain indicated. The floor drain should have a bell trap which will prevent foul air backing up through the drain.

Concrete in walls and roof must be reinforced, the proper amount and location being indicated on the drawings. For the walls, the rods should be kept as near the center of the walls as possible, while for the roof they should be kept about ¾ inch above the bottom of the slab.

Every other rod should have the ends bent up as indicated.

Forms for the walls may be removed in about a week of good weather, but in cool weather they should remain in place longer. The roof forms should remain at least three weeks and then be carefully removed.

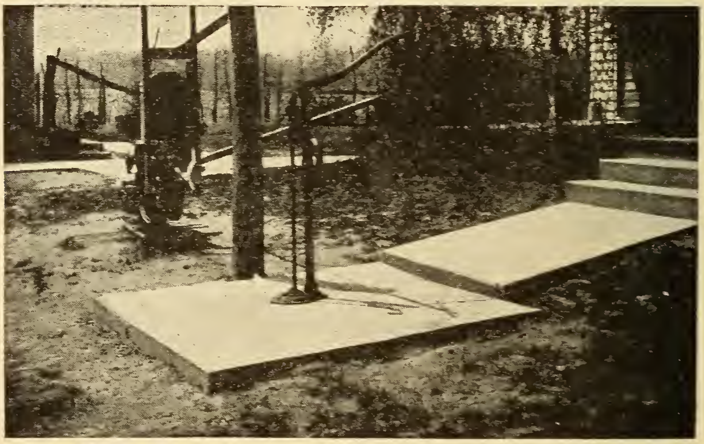


Vertical section through rectangular concrete milk cooling house, showing reinforcing requirements for roof slab.

More concrete dairy houses will help to save a part of the 30 per cent waste of dairy products now common on the average farm. They will make the work easier as well as more profitable.

CONCRETE LINING FOR THE WELL

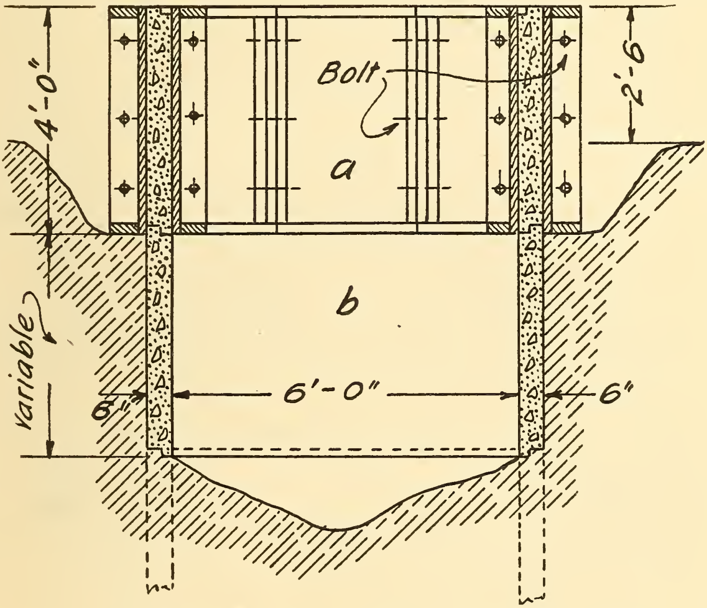
Importance of Keeping Drinking Water Pure. One of the most necessary appointments of the farm is a well to furnish a supply of good, pure drinking water, and a well should be so located and lined that the water will



be protected against all possibility of contamination from outside sources. The old wooden well lining and cover not only permits particles of soil and vegetable matter to drop into the water but soon reaches a state of decay when it becomes a source of danger to life and to limb from contamination and possibility of accidents. The top covering becomes loose, boards are pushed into or dropped down the well and the opening is a serious menace to farm animals and children about the place.

How to Line a Well With Concrete. Concrete well lining and platform will overcome and for all time prevent

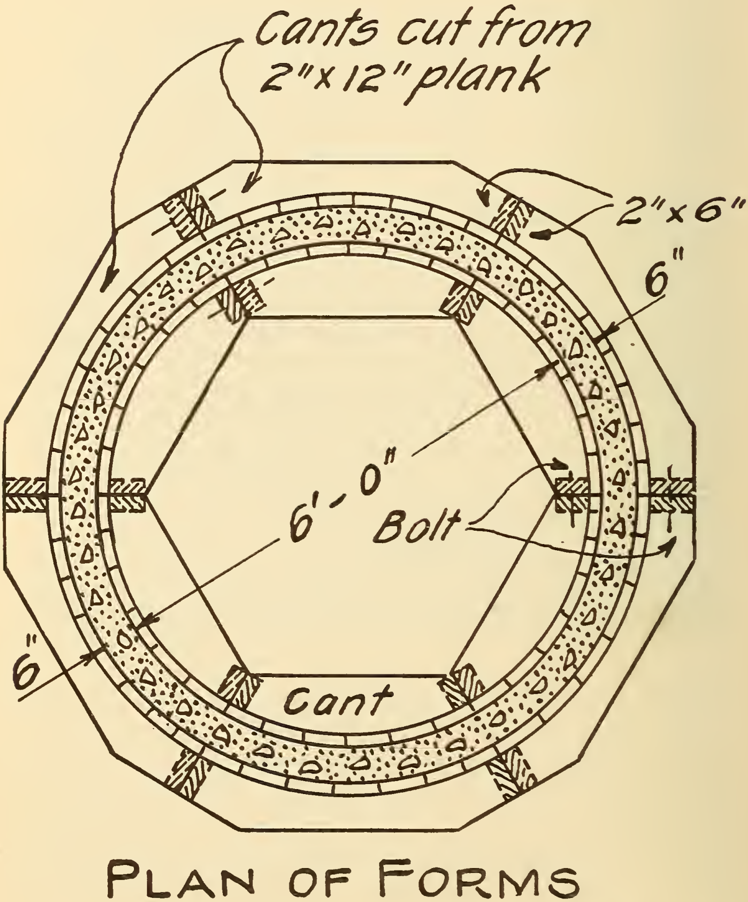
these dangers. The concrete well lining should extend down into the well from 6 to 8 feet or sufficient depth to



Some details of forms for building concrete well lining.

prevent burrowing of animals and seepage through the upper layers of soil. In localities where an underground water stratum of undesirable quality is found at greater depth than this, the lining should be extended down far enough to exclude such water. In lining a well with concrete first remove the top cover as well as the old lining down to the desired depth. At that depth a platform must be built to form a stage on which to work. This platform may rest on the old lining or else be supported against the soil within the well. With this platform in place and all of the old lining thoroughly removed, forms for the new lining may be built. These should consist of

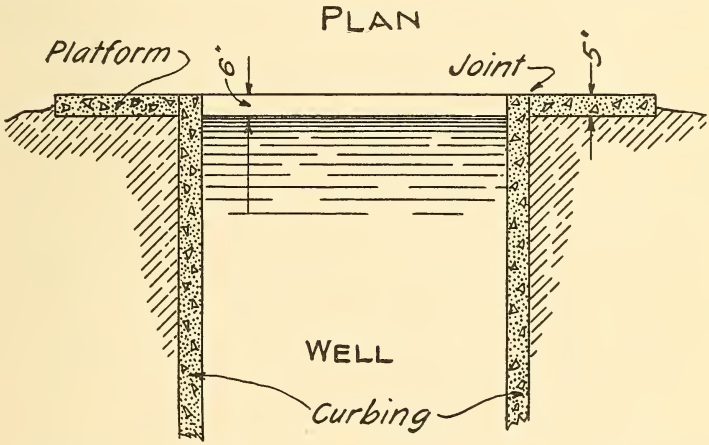
1 by 4 inch strips beveled at the edge to permit their being placed around in a circle with tight joints facing the con-



Sketch showing method of building forms and assembling them for concrete well lining.

crete. One of the accompanying illustrations shows this in the sectional plan of forms. These boards should be

braced by 2 by 4's at sufficient intervals to insure that they will not bulge or give way under the pressure of the fresh concrete. These forms are 4 feet long as shown in the sketch of the vertical section and are so bolted together that they are easily collapsible when necessary to take them down. As a rule only interior forms will be needed if they are braced and blocked sufficient distance from the earth wall when concreting. After the form section has been filled with concrete the forms should be left in place

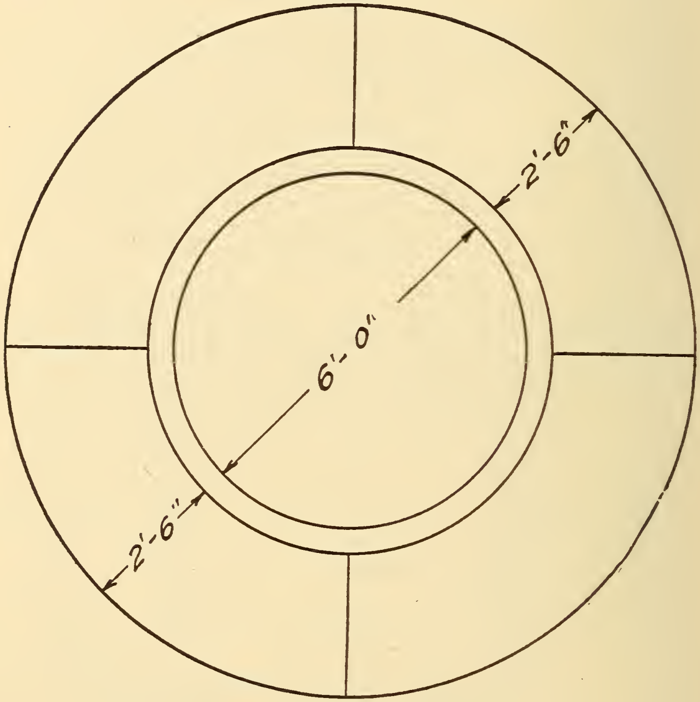


Section through well showing concrete lining and platform at ground level.

until the concrete has thoroughly hardened. Then they may be removed and a support or platform built for casting the concrete cover slab or if this is not too large to be handled in place by three or four men, it may be cast separately in a form made for that purpose and when it is hardened be moved to its position over the well curb.

A platform not less than 4 inches thick and reinforced with ¼ inch round rods 8 or 10 inches center to center should be made. An opening must be provided for inserting the pump and another one to serve as a manhole which

may be necessary if the well has to be cleaned out at some time. A tight fitting concrete cover should be made for



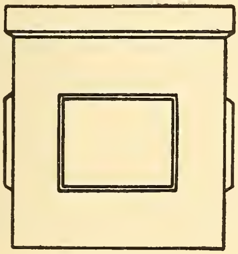
Plan of concrete pavement on ground around well lining or curb.

this manhole, provision being made for it when the cover slab or platform is cast. The edges of the manhole opening should be beveled and the cover for the manhole opening correspondingly beveled to fit into this opening.

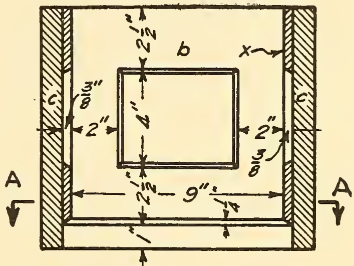
Concrete for a well lining platform should be mixed not leaner than 1:2:4 although a 1:2:3 mixture is preferable. The pebbles or broken stones used should not exceed 1 inch in largest dimension.

DETAILS OF A FORM FOR A SIMPLE FLOWER BOX

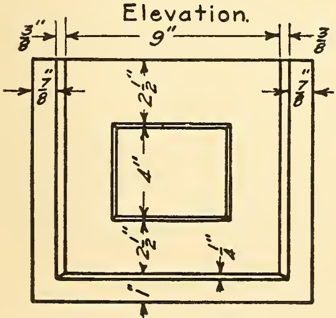
In the section on forms there was illustrated details of a form for solid concrete block 9 inches square by 6 inches high. Accompanying sketches show how this form, by slight extension, may be adapted to casting an object with raised panels, or if raised panels are not wanted, then



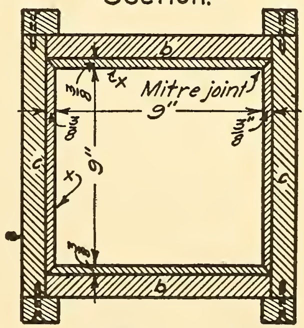
Elevation.



Section.



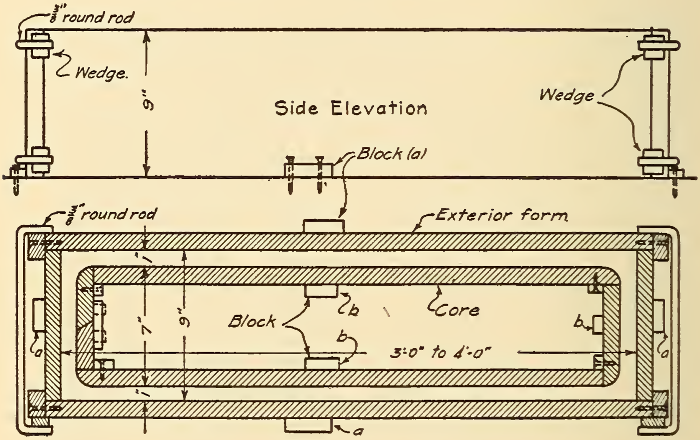
Detail of side "c"



Section A-A.

depressed ones may be provided by cutting out suitable recesses in the inside form face. By a little elaboration this form can be extended to cast a rectangular flower box. Forms necessary are similar in every respect to the simple

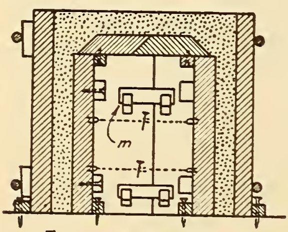
square forms previously illustrated and described below. In order to prevent the sides of the form from bulging in or out when placing or tamping concrete, braces should be placed at convenient points along the



Plan of Form and Core Assembled

Extension of the preceding design adapting it to a longer type of flower box.

sides. These will keep the form pieces properly lined up. Blocks *a* and *b* are nailed to the work bench to keep the outside form and core from shifting. The upper sketch shows a variation of the form to provide for depressed panels.

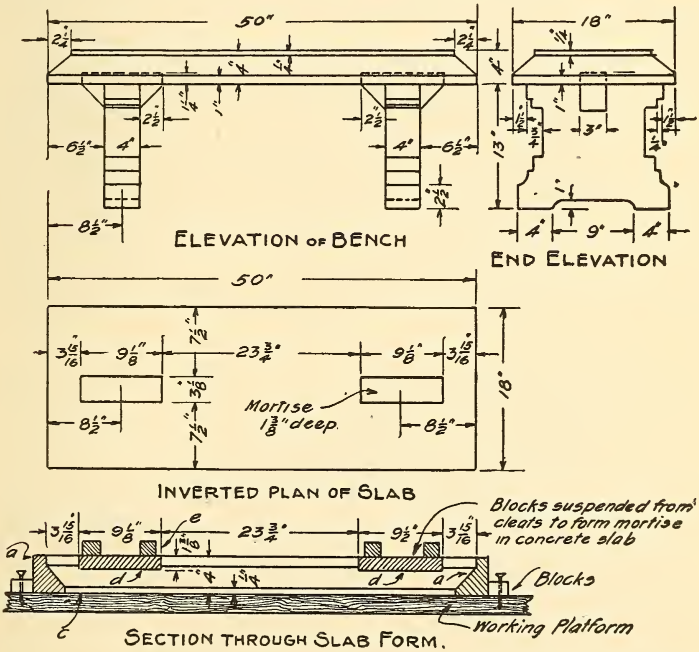


Form Assembled Showing Concrete in place

Section through form showing concrete in place and core for small rectangular flower box. Various details of form construction and elevation of rectangular flower box showing method of varying exterior by changing from depressed to raised panels.

DETAILS FOR CONCRETE GARDEN BENCH

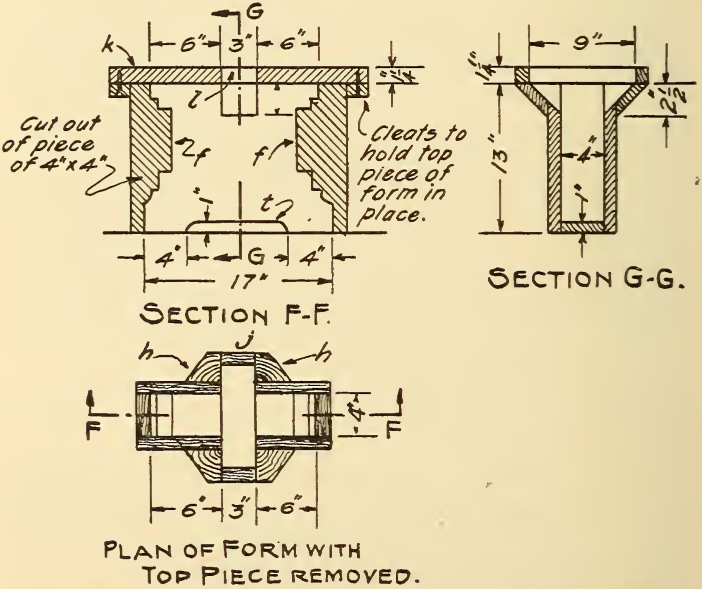
One of the most attractive pieces of garden furniture that can be made of concrete is a lawn seat such as shown in sketches detailed herewith. The form for the seat slab consists of part *a*. This has mitred joints and as assembled



Details of concrete lawn or garden seat showing bottom plan of slab, side and end elevation and section through slab suggesting method of constructing forms.

is held in position on the workbench by small blocks. Part *a* when made of the shape shown should always terminate in a small member *c*. If the curve is brought down to a feather edge the concrete soon slivers off. Mortises are formed by holding part 4 in position shown

by means of cleats *e* extending across the top of the form. Legs of the bench are shown as the pieces *f, g, h, j, k, l, m*. Piece *f* is cut out from one piece by a band saw and the surface smoothed with sand paper. Brackets are formed by nailing parts *h* to the side. Sides are cut out at the top for brackets. Part *j* is nailed to parts *h*. Part *t* is nailed to the work bench in proper position, the legs right



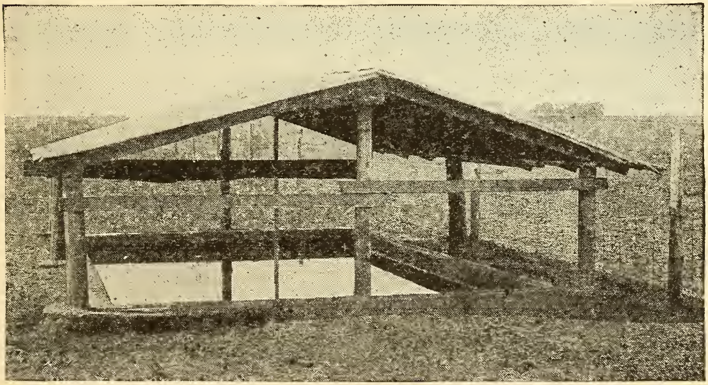
Details of form construction for casting legs for lawn bench.

side up. Concrete is placed in the form from the top after which piece *k* is set in place and the opening *l* filled with concrete. Care should be taken to have the tenon *l* and mortise *d* in proper position so seat slab can be properly assembled. Reinforcement in the seat slab may be ¼ inch round rods spaced 6 inches center to center or some one of the several kinds of reinforcing fabric. Reinforcement should be placed near the lower edge of the slab.

CONCRETE WALLOW FOR THE HOG LOT

One of the most profitable structures for the farm where hogs are kept is a concrete wallow where the animals can cool their skin during hot weather and can find the great comfort that the hog wallow affords in helping to rid them of lice and other parasites.

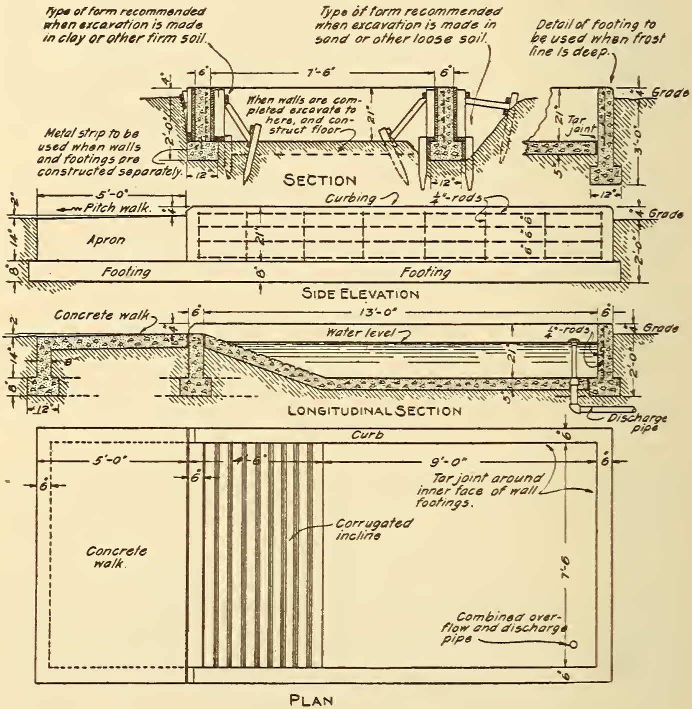
In the sketches shown of a concrete hog wallow it will be seen that many of its details are like the concrete manure pit or concrete trough. The wallow, of course, is built so that the top of side walls is at about ground level. Excavation should be made the required depth, which in this case is 2 feet below grade, and the soil where the floor or the bottom of the wallow is to be laid should be thoroughly compacted. Various sketches show the details



Concrete hog wallow which has the added feature of a roof to protect animals from heat of sun.

that make almost all features of the construction self-evident. One of the sketches shows a section which illustrates the simple forms necessary for this work. A footing

is shown on the side and end walls but this is not necessary unless the soil is not firm. Reinforcement of the walls consists of ¼ inch round rods spaced 6 inches apart



Transverse and longitudinal sections of concrete hog wallow showing suggested details of form construction, also a plan of the wallow giving all dimensions.

center to center horizontally and 2 feet vertically, these rods being tied together where they intersect. Arrangements must be made for an inlet pipe, which by suitable valve connection, can also be made to serve as overflow when the required quantity of water is in the tank.

At one end the wallow floor slopes upward to make it easy for animals to get in and out of the wallow. This

sloped section is shown with small corrugations in the surface provided to enable the animals to secure a more certain foothold when entering and leaving. At the entrance end there is shown a concrete pavement placed there to keep the immediate surroundings at entranceway from working up into a mudhole. This pavement is 5 feet wide and 8 feet long. The interior dimensions of the wallow are 7 feet 6 inches by 9 feet for the top portion with an added 4 feet 6 inches of length at the end where the floor slopes upward for an exit.

In concreting a 1:2:4 or 1:2½:4 mixture may be used of quaky consistency. Enclosure walls are built first. After these are hardened and forms may be removed, the concrete floor is laid, remembering to provide suitable arrangements for inlet pipe. An earth fill is placed to required grade at the end where the floor slopes upward for an exit.

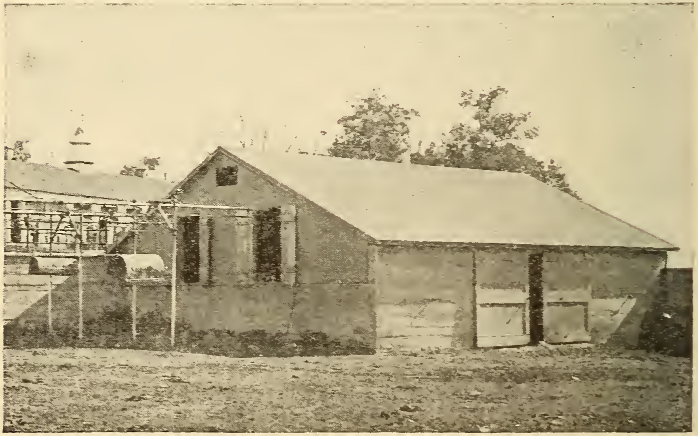
The hog wallow should be located where it will be convenient to pipe clean water into it and likewise to drain and clean when necessary. This suggests a slightly elevated spot as a desirable location.

It is very easy to arrange an accessory compartment or pit in which a valve mechanism can be placed similar to those used in connection with flushing bowls of the interior toilet. Such mechanism will automatically control the amount of water kept in the wallow.

Various kinds or types of solutions are on the market which can be poured into the wallow and will float on the surface, thus making the application of medication or insecticides automatic. In other words, the hog will do the work himself.

DESIGN FOR CONCRETE MANURE PIT

Manure Pit Saves Waste. The U. S. Department of Agriculture has estimated that millions of dollars worth of fertilizer could be saved annually if every farm had a concrete manure pit where stable wastes could be properly conserved.

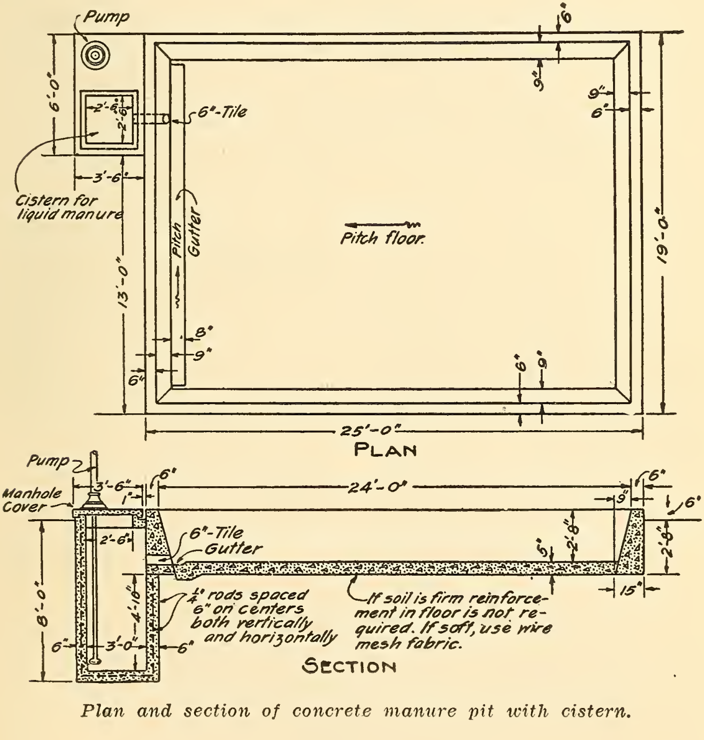


A fine covered concrete manure pit with double litter carrier. This structure makes certain that all of the valuable contents of the manure will be preserved.

A manure pit is a form of tank in that it must be watertight to hold liquid contents which are the most valuable part of stable manure. It is also desirable that the pit be roofed over to prevent surplus water from rains accumulating in it and thus preventing controlled decomposition of the contents.

Manure pits are made in various ways, depending upon the location and quantity of manure to be handled into them. Some are built so that the top or side walls are level with the ground; some are built so that the floor is on

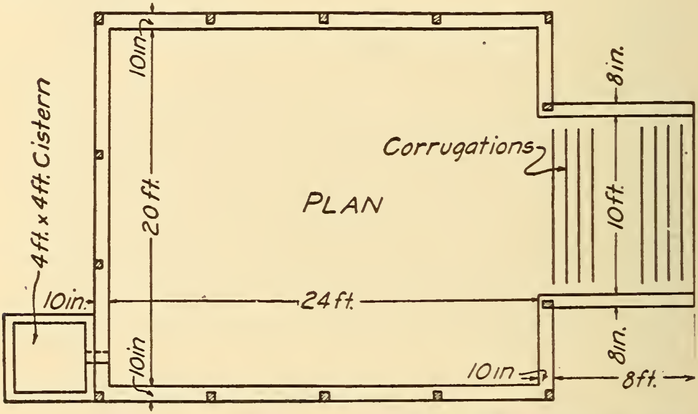
a level with the ground and the side walls two or three feet above it; some are built with the floor below ground and walls partly below and above, in addition to which they are frequently arranged so that a wagon can back into one end or perhaps drive in one end and out the other. Particular style of pit will necessarily be governed by individual requirements.



Plan and section of concrete manure pit with cistern.

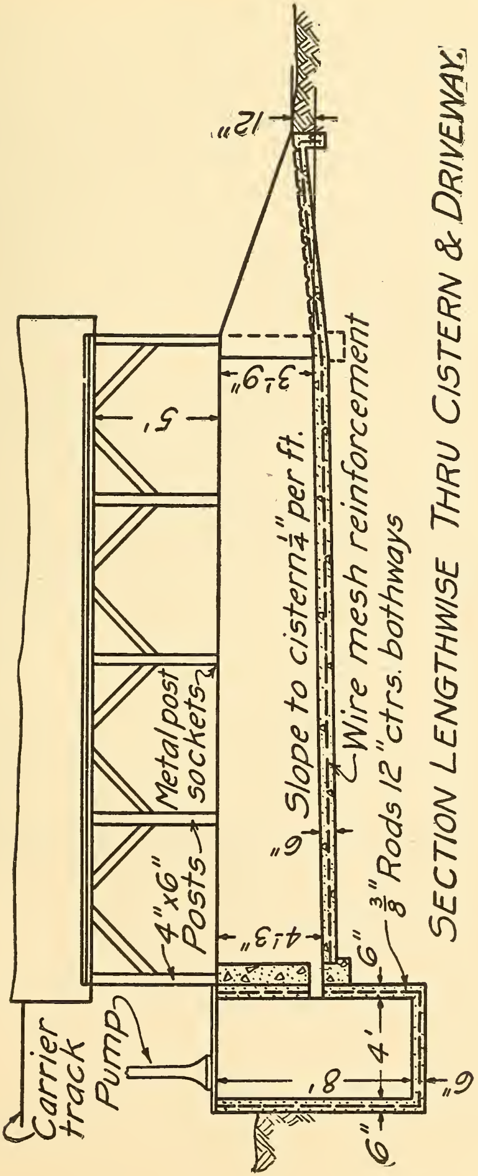
Details. Accompanying drawings suggest plans and sections of small concrete manure pits with cistern. The cistern is desirable in order that excess liquid content may flow into it and from this container be pumped to a tank wagon for distribution over the soil as desired. The con-

struction of this cistern is in all fundamentals the same as that of a cistern illustrated and described elsewhere for water. The plans show principal details of the work. At one end of the pit is a gutter to which excess liquids drain and are led to the 6 inch tile line entering the cistern. The floor of the pit is pitched slightly so that liquids will drain towards this gutter. Walls of the pit are 6 inches thick at the top and battered on the inside so that they are 15 inches thick at the bottom. Inside depth of the pit is 2 feet 8 inches. It is paved with a concrete floor 5 inches thick.



Plan of concrete manure pit with cistern. This plan provides driveway slope by means of which wagons may be backed into the pit for loading.

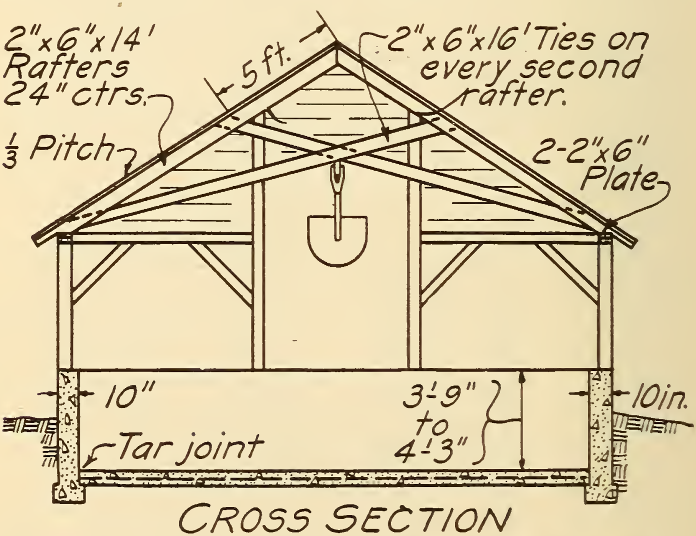
If the soil is firm no reinforcement is required in the floor, but if not firm then the floor should be reinforced with ¼ inch round rods spaced every foot or 18 inches center to center or with some one of the several kinds of wire mesh fabric used as concrete reinforcement. The cistern which is shown in section with the section of the concrete manure pit has about a 5 feet clear depth for liquid without permitting return flow to the manure pit. It is 3 feet wide by 5 feet long inside measurements. Re-



Longitudinal section of concrete manure pit with roof and adjoining concrete cistern.

inforcement of manure pit side walls is not necessary except to prevent possible settlement. Otherwise the only reinforcement needed will be two rods about 4 feet long, bent around each corner and embedded in the concrete to prevent cracking at corners from expansion due to temperature changes.

Capacity of pit must be regulated by the number of stock to be kept. A pit of the dimensions shown in the drawings is of sufficient capacity to accommodate the stable wastes from about 15 cows. Usually the manure pit is



Cross section of concrete manure pit showing position of litter carrier.

so located that it is directly in line with the cleaning alley in the barn so that the litter carrier can run directly from this alleyway into the pit.

Concrete mixture for a manure pit should be 1:2:4 or 1:2½:4 although the cistern should be of 1:2:3 mixture. The floor is of one course construction and need be finished

only with a wood float. It can be divided into any required number of slabs, depending upon the amount of concreting that can be done during the particular time that may be devoted to this work. After the floor has been placed the joint all around where floor joins side walls should be picked out sufficiently to permit sealing with tar or calking with tar soaked oakum.

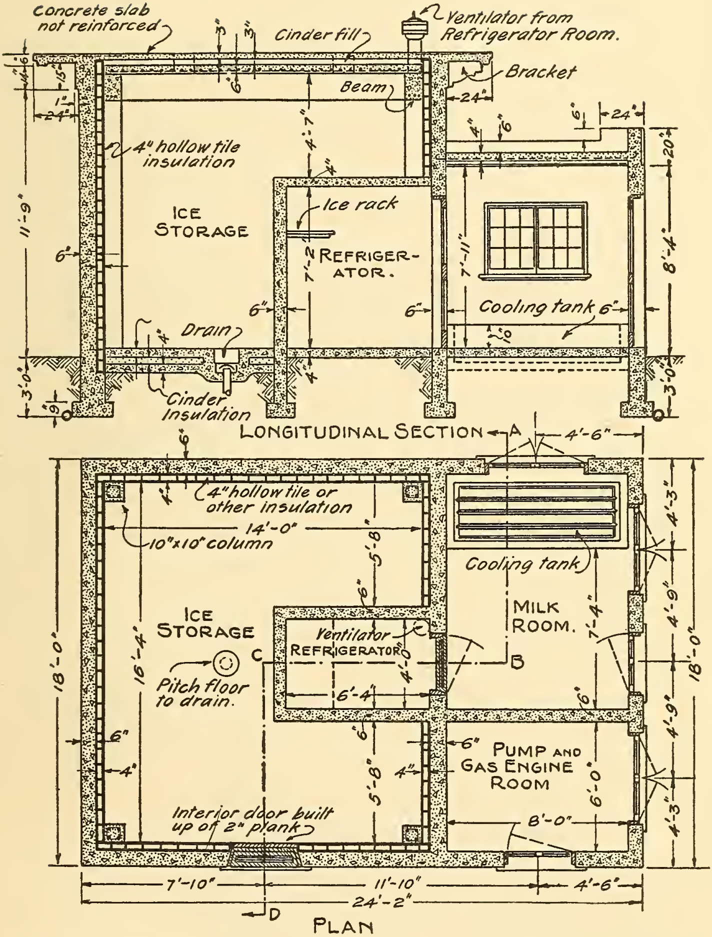
AN ICEHOUSE FOR THE HOME SUPPLY OF ICE

Advantages of Storing Ice. The farmer will find an icehouse not only a convenience but a profitable addition to his farm building group. The dairy farmer should realize that to him such a structure is a necessity. Estimates that seem to have proved conservative indicate that 30 or 40

Monolithic concrete icehouse.

per cent of the value of dairy products on the farm is lost because of improper facilities or the absence of facilities for caring for them until marketed. Over 80 per cent of dairy products needs the protection of refrigeration.

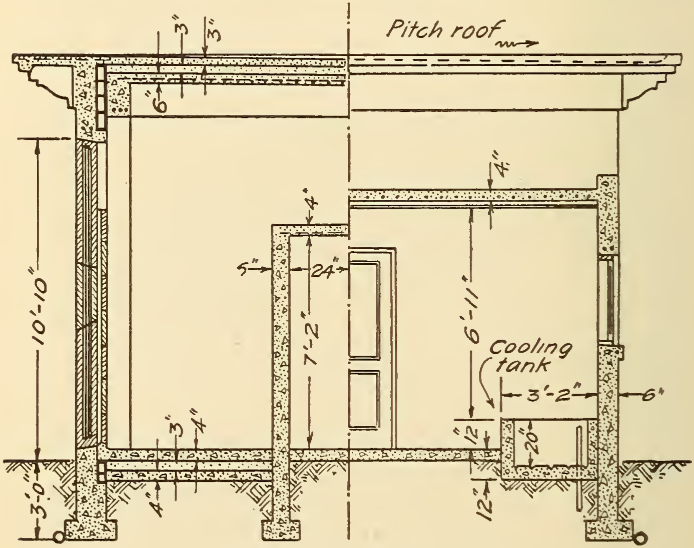
No doubt the greatest deterioration of dairy products on the farm occurs simply because few farms are as well equipped as they should be to handle milk, cream, eggs and



Plan and sectional view of concrete icehouse combining refrigerator compartment, milk room and cooling tank, pump and gasoline engine room. This design shows monolithic concrete, veneered on the inside face with hollow tile for insulation. The concrete roof is double, separated by a layer of cinders, also for insulation.

dressed poultry as they should be until they can be started to market.

The farmer should have an icehouse that will hold and preserve sufficient ice to take him over the seasons between ice harvesting. In building an icehouse there are two conditions to be considered, the cost of the house and the cost of the ice. In most cases the ice costs nothing more than the labor of harvesting and storing, and as farm hands



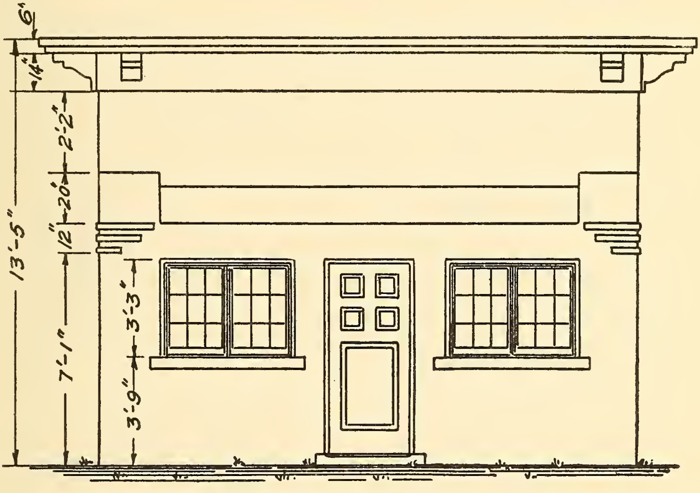
SECTION A-B-C-D

Combination section of combined icehouse and milk house.

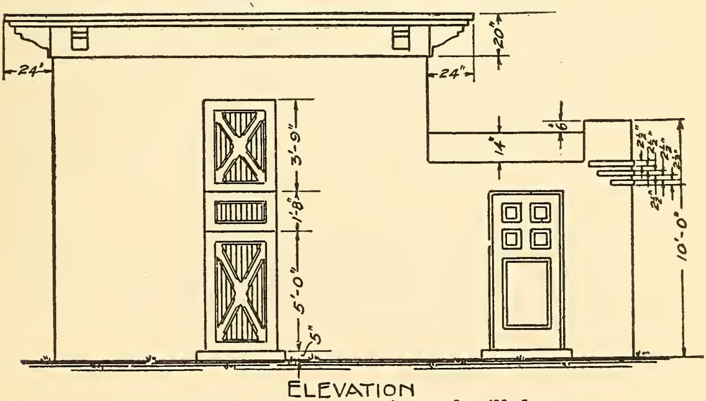
have more idle time during winter than at any other season, the matter of ice harvesting simply amounts to conserving time.

Fire Risk in Icehouses. Perhaps it may seem strange that there is a special fire risk involved in the storage of ice. Nevertheless this is true. Many icehouses are set on fire through spontaneous combustion. Sawdust, hay or straw is used for packing and probably the variable mois-

ture content in these materials causes decomposition and consequent heating in a way similar to the heating of manure. This frequently results in fire.



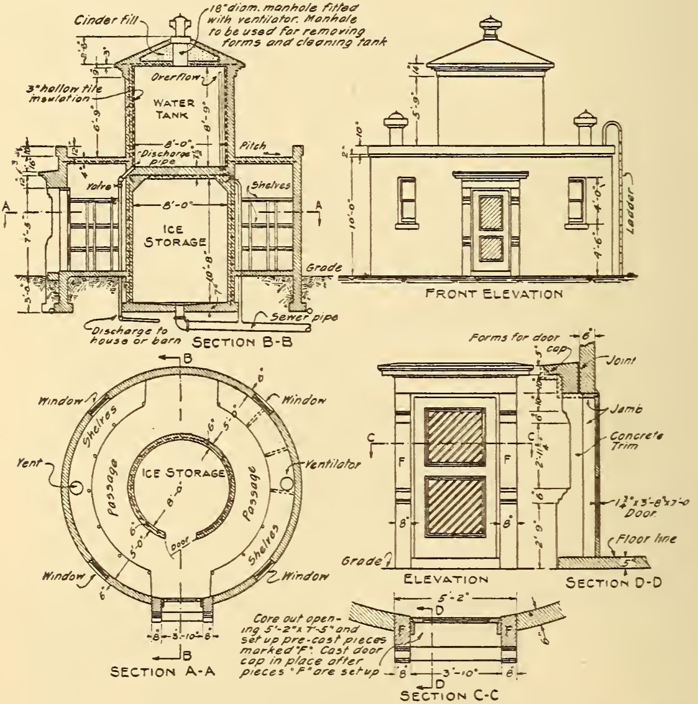
End elevation of concrete ice and milk house.



Side elevation of concrete ice and milk house.

Why Concrete Icehouses Are Best. Wood is a poor material from the economic standpoint to use in icehouse construction. It is not fire-safe and soon rots out owing to

the alternate wet and dry conditions to which exposed when the house is filled with ice and to the neglect to which it is subjected when empty. For this reason concrete is especially to be preferred.

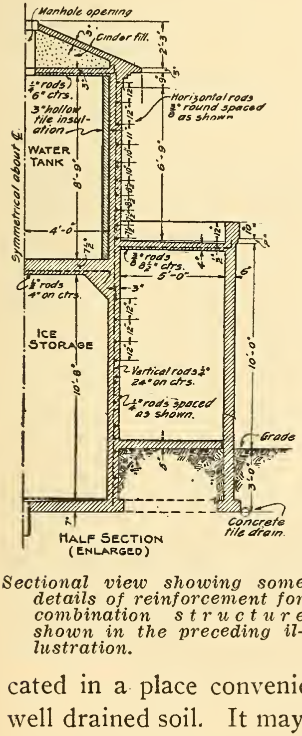


Another combination ice and milk house and cold storage structure combining an elevated concrete water tank. This structure has not been detailed with respect to reinforcement required, but the design has been presented merely as a possibility for construction with commercial silo forms and illustrates the adaptability of circular construction.

Design for Concrete Icehouse. Accompanying sketches offer suggestions for a concrete farm icehouse. It is quite a simple matter to extend a concrete refrigeratinng compartment into the ice storage room so that this compartment will always be surrounded with ice and hence

serve as an actual cold room for eggs, dressed poultry, milk and cream. Either block or monolithic construction can be used and because of ease with which insulation is secured hollow block construction is especially desirable.

The concrete floor should be sloped in all directions toward a central drain. It should be made independent of the side walls and should be so laid that there will be a ½ inch joint all around which can be sealed against leakage and entrance of air by pouring into it hot tar or asphalt. The drain is trapped so that water from ice leakage will seal it against possible entrance of air, thus preventing rapid melting of ice.



Sectional view showing some details of reinforcement for combination structure shown in the preceding illustration.

Practical dimensions for a small icehouse are 10 by 10 by 10 feet. An icehouse of these dimensions contains 1,000 cubic feet and as a cubic foot of ice weighs approximately 57 pounds, it is estimated that the capacity of this room would be 40 pounds per cubic foot, allowing for the usual waste of space necessary for packing the ice, so a house of these dimensions will hold about 20 tons.

The icehouse should be located in a place convenient to the dairy barn and on dry, well drained soil. It may be combined with the dairy building or milk house.

Frequently the icehouse or ice-storage room has been built below the surface of the ground. This makes it very difficult to fill and equally difficult to remove ice from,

since it must all be carried up to ground level before it can be used for domestic purposes. Also the soil is a good conductor of heat and it has been found that ice melts much more rapidly in ground storage than in a properly built structure above ground.

The concrete floor should, in a measure, be insulated from contact with the soil by being on a well compacted 8 or 10 inch layer of clean pebbles or cylinders. If block are used throughout the construction the type of block must be such as to permit suitable reinforcing of walls to take care of outward thrust resulting from ice pressure.

To provide proper insulation for the roof it should be laid as two separate slabs separated from each other by a layer of clean cinders.

USE OF CONCRETE IN TREE SURGERY

Many a fine old tree, the heart of which is being eaten out by decay, can be saved by the intelligent use of a little concrete. As nearly everyone knows, most trees grow by the yearly addition of a new ring to the wood immediately under the bark. This new ring, known as sap-wood, may be likened to the arteries in the bodies of men and animals; without it the sap, which is the blood of the tree, could not make its way from the roots to the branches.

Tree cavity before and after filled with concrete as described in the accompanying text.

Cavities occurring from any cause gradually increase in size until through lack of nourishment the tree suffers, weakens and eventually dies.

Wonderful advance has been made in tree surgery. This has led many persons to undertake the treatment of their own trees without understanding that success can be obtained only by observing certain practice. In the first place the cavity should be thoroughly cleaned. If you ever had a tooth filled you will recall the dentist's painstaking, painsgiving deliberations in this respect. As with a tooth so with a tree. Decaying wood or fungus growth left in a cavity under the concrete will cause decay to continue.

After the cavity has been thoroughly cleaned and scraped, it should be treated with some germicide like creosote, crude petroleum, or copper sulphate solution made by dissolving ¼ pound of copper sulphate, commonly called "blue stone." or "blue vitriol," in ten gallons of water. Following a thorough washing out with this solution a thick coating of hot tar should be applied to act as a "spring" or expansion joint to prevent the wood from cracking the concrete. If the cavity is large the concrete should be reinforced. This may be accomplished by driving a number of twenty penny nails in the cavity or by using ¼ inch round rods extending from side to side of the opening. The kind and amount of reinforcement will depend upon the shape and size of the cavity.

Before beginning to fill it, the cavity should have been thoroughly treated as described and the bark surrounding it should be cut back ½ inch from the face of the opening. A 1:2:3 concrete should be mixed, in which coarse aggregate does not exceed ½ or ¾ inch in greatest dimensions. Concrete should be thoroughly mixed so that the least amount of water necessary for manipulation will be present. If the cavity is so open that a form is required to hold the concrete while hardening, sheets of tin may be tacked to the tree and across the openinng after it has been filled with concrete. When the concrete is partly

hardened, which will be a few hours after placing, the tin should be removed so the surface may be finished to conform to the natural shape of the tree in order that no deformation may appear after the bark shall have grown over the concrete filling.

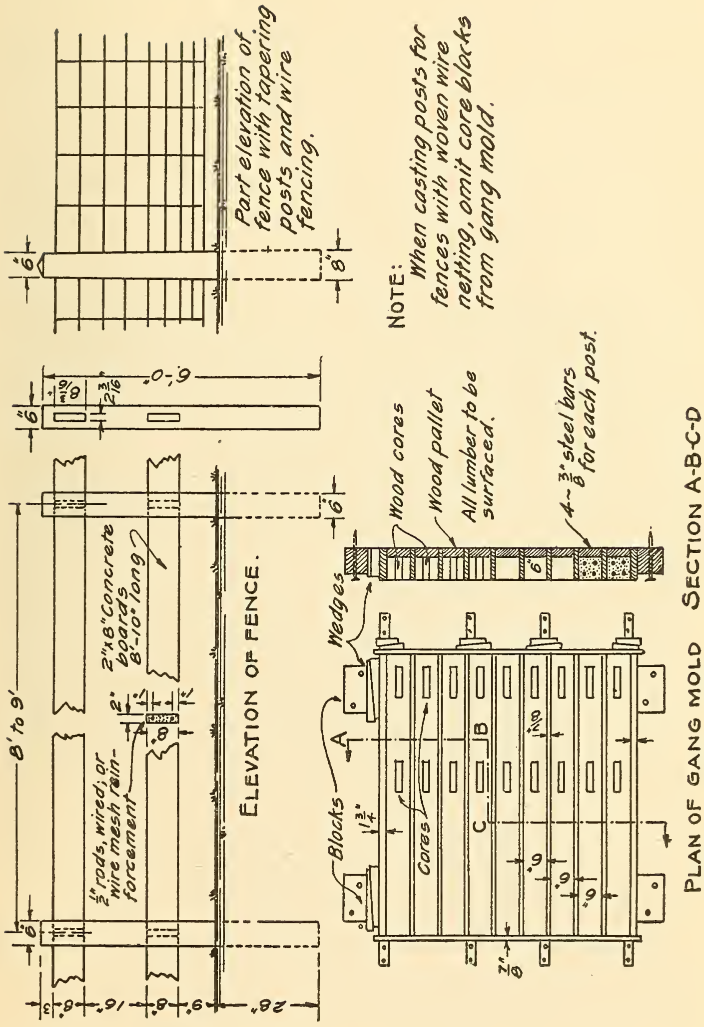
Damp burlap or other moisture retaining material should then be lightly fastened over the concrete and be kept moist for a week while it is hardening.

DESIGN FOR CONCRETE FENCE AND GANG MOLD FOR POSTS

Some very attractive fences of concrete have been built of precast units assembled on the site. Such fences are permanent throughout, are not in danger of damage by fire and do not require the maintenance necessary to wood fences, from which boards are always pulling loose or falling off. In designs shown there is illustrated a post of

Concrete post and panel fence similar to that illustrated in accompanying sketches.

6 inch square section with mortises cast in opposite faces into which the concrete units corresponding to boards are set when the fence is assembled. The concrete boards are 2 inches thick and 8 inches wide, reinforced with ½ inch rods, wires or wire mesh. Each board is 8 feet 10 inches long. The lower left hand sketch shows a gang mold with cores all assembled for



Details of concrete post and panel fence in which the panels are precast concrete boards. Also sketch showing gang mold in which posts are cast and suggested details of form construction.

casting the posts. This form is built of ⅞ inch lumber planed on both sides and when the form is in use is assembled on a level wood platform. Posts of this kind should be reinforced by four ⅜ inch steel bars in each post set back about ¾ of an inch from the corner.

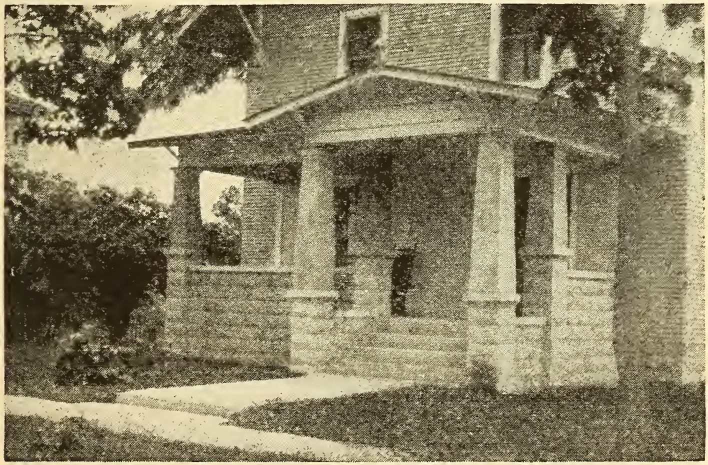
Concrete mixture for this kind of work should be a 1:2:3 in which coarse aggregate is not larger than ½ inch. Larger aggregate will not permit working of the concrete in such thin sections as the boards and it is very important concrete everywhere surround and bond to reinforcing rods in each one of these concrete boards. As in fence post manufacture it is necessary to use a concrete mixture containing slightly more water than would be used in most work and in casting the units it is well to settle the concrete by tapping, jarring or otherwise vibrating the mold so that air bubbles will be released from the concrete and maximum density will result.

The units of which this fence is composed require the same care in handling prior to use as any other concrete product. Posts must not be removed from the forms until they have hardened sufficiently to be proof against failure from handling. Usually this will necessitate leaving them in the mold for several days at least. Even after this time they should not be set up on end where they will have to bear part of their own weight, but should be covered with wet covering so that the concrete will harden in the presence of moisture.

The gang mold shown can be used also in casting concrete posts without mortises which can be used as shown for stringing ordinary wire fencing.

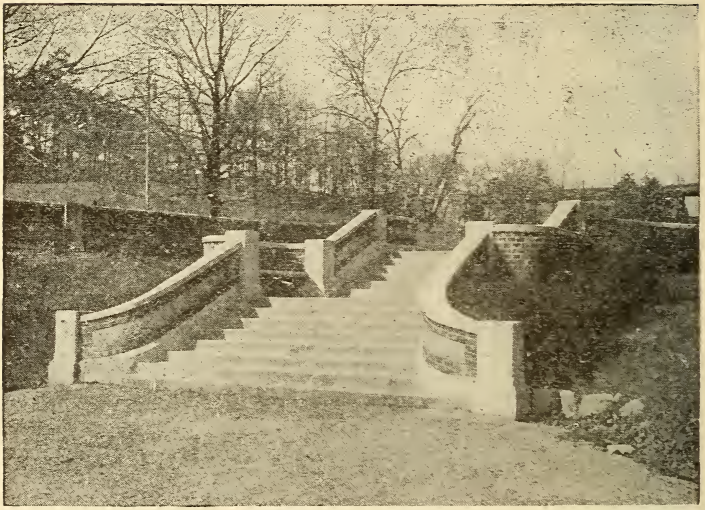
CONCRETE STEPS

Most woods in contact with the soil, especially when lying on it rather than buried in it, rot rapidly. Probably no home worker has escaped the necessity of renewing the steps at the front or back of the house one or more times. When wood is used for such a purpose it is easy to see that each time renewal is necessary just that much

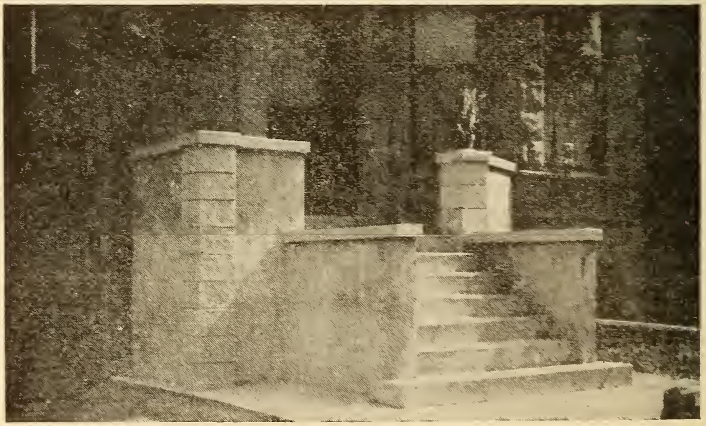


Monolithic concrete and concrete block have been combined in this porch.

labor and material are lost. Building for permanence by using concrete involves little if any greater expense than to build impermanently of wood. Furthermore construction such as required either for front or back porches or side steps is relatively simple. Forms are the easiest possible to build and no tools other than those usually found about every farm are necessary for the work. Take the steps at the back of the house by way of example. An



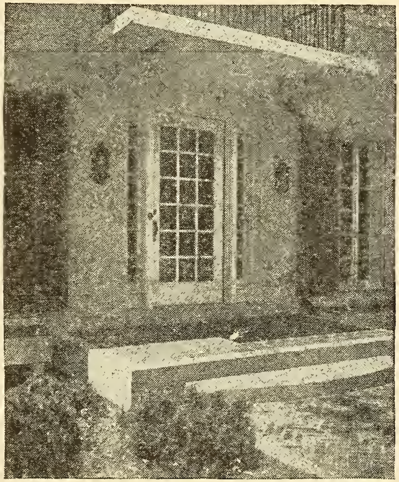
An example of attractive concrete terrace steps in which pleasing ornamentation has been produced by inlay of brick.



Example of concrete porch construction in which concrete block and monolithic concrete are combined.

illustration suggests the simple forms required to build uncovered porch steps.

Before commencing the work the ground should be leveled and any spots or vegetation such as sod dug out and removed. Then the area where the steps are to be placed should be filled in with clean, well compacted

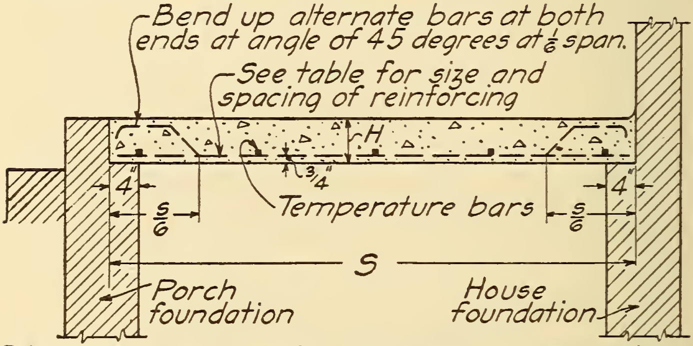


An example of porch detail worked out with concrete.

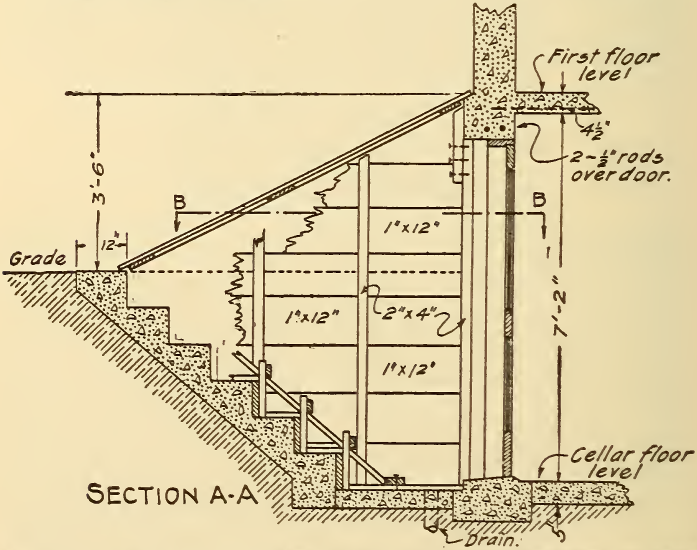
gravel. Arrangements should be made to mix and place the concrete so that the work will be continuous from start to finish. Small steps will not require more than a few hours of work so there need be no construction seams.

Concrete mixed in proportions of 1:2:4 or 1:2½:5 will be well suited to the work. Pebbles larger than 1 inch, also field stones, may be used on the interior of the mass but it will considerably reduce the labor of finishing the surface of the concrete if no pebbles or broken stones larger than 1 inch are used in the concrete placed against the forms. Under favorable summer weather conditions forms can be removed within 24 hours from the work

and then any stone pockets or similar imperfections occurring on the surface can be filled with a 1:2 or 1:2½



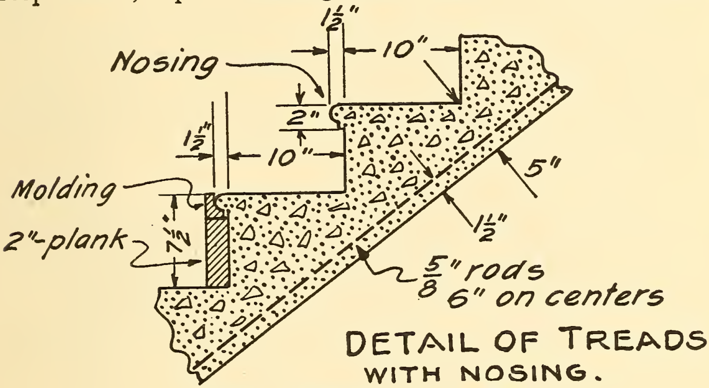
Reinforcement for concrete floor slab intended as porch floor with other details of construction permitting this feature to be adapted to any existing structure.



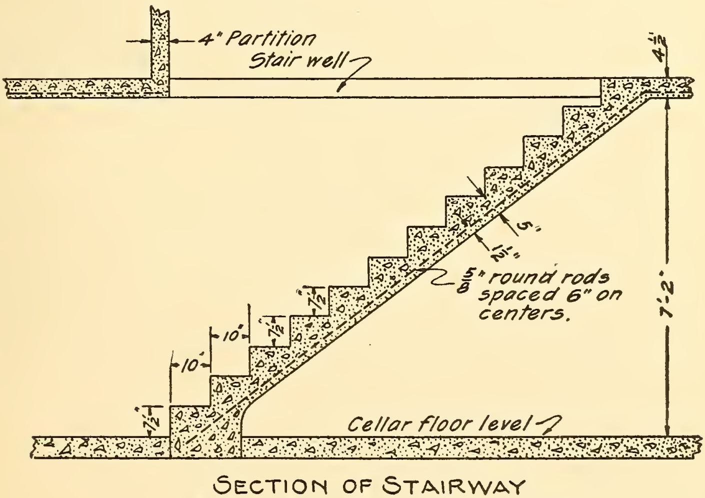
Section of concrete steps giving suggested form construction for such steps when used as cellar entranceway, also showing the relation of steps to concrete foundation and floor.

sand cement mortar. The whole surface may then be floated, that is, wet down and rubbed while it is wet with

a carborundum brick, wood float or similar finishing tool. If forms are filled to within an inch of the top of step treads, top or wearing coat mixed 1:2 or not leaner



Detail of step treads with nosing.

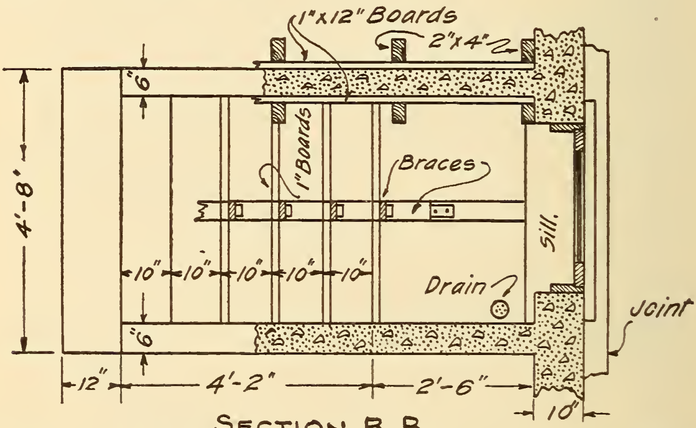


Section of stairway from cellar to first floor showing reinforcement required.

than 1:3 can be applied before the mass of concrete has commenced to harden. After the forms have been re-

moved the steps should be protected by some kind of covering that will prevent too rapid drying out.

Work like this, because of its considerable mass can well be done during early spring or late fall when the weather is quite cold, providing there is no frost in the ground and proper care is taken to protect the concrete against freezing for at least 48 hours until it has undergone early hardening.



Section through side walls of cellar steps showing method of bracing forms when concreting these side walls.

Principles of step construction are practically the same for all classes of steps and illustrations elsewhere also suggest a variety of uses for steps which may well be built of concrete. Replacing porch walls and foundations with concrete in connection with concrete steps is also a profitable use of this material.

A design for reinforcing concrete porch floors of certain width is shown which will enable anyone to build complete a concrete porch. Even porches can be varied to certain extent by building of block instead of monolithic and by using precast concrete units for balustrades, columns and railings.

Other drawings give detail of steps used for entrance to cellars and approach to terraces, etc.

SCHEDULE OF REINFORCING AND THICKNESS OF SLAB FOR CONCRETE PORCH FLOORS OF DIFFERENT WIDTHS

Width of Porch S Feet	Thickness of Slab H Inches	Size of Reinforcing Inches	Spacing of Reinforcing Inches
4	4½	¼ round	8
5	4½	¼ "	6
6	4½	⅜ "	9
8	5	⅜ "	6
10	5	⅜ "	4

NOTE—Use ⅜-inch round temperature bars 12 inches on centers on top of main reinforcing bars. Place main bars ¾ inch from bottom of slab.

CONCRETE DRAIN TILE

Old Methods of Drainage. Up to a few years ago land drainage was generally accomplished by stone or brush lined drains or by using various kinds of clay tile. In recent years one of the extensions of the use of concrete has been the manufacture of drain tile, and this field has grown so rapidly that concrete drain tile now occupy a very important place in land drainage.

Early Use of Concrete Tile. Just as mistakes are often made in the beginning of any new industry, or sometimes in applying old material to a new industry, so were mistakes made by early manufacturers of concrete drain tile, or as they are sometimes called, cement tile. These early failures subjected concrete tile to severe, yet just, criticism. Now the requirements for success in drain tile manufacture are so well known and have been so long applied that concrete tile are giving efficient service, equal to and perhaps greater than any other type of tile on the market. In addition they have some distinctive merits to single them out for preference.

Quality of Materials. As in all concrete products, proper selection, proportioning and mixing of materials for drain tile manufacture are vital to success. Sand must be clean and well graded. It should range from the finer particles to those that will pass when dry a screen having four meshes per linear inch and should preferably be siliceous material, free from loam, dust, soft particles, vegetable or other foreign matter.

Size of Tile. For most of the average farm drainage requirements, tile will vary from 4 to 10 inches in

diameter. So, on account of the thickness of tile walls, it is not practicable to use sand or aggregate in which the particles exceed ¼ inch. However, where tile or pipe of a size having a wall of sufficient thickness to use larger material are being made, then the maximum size of aggregate may range to ½ inch, provided the entire bulk of aggregate is properly graded so as to eliminate voids or air spaces to the greatest degree possible.

Concrete Mixtures to Use. For drain tile up to and including 10 inches in diameter, concrete should be mixed in the proportion of 1 sack of portland cement to not more than 3 cubic feet of sand. For drain tile over 10 inches in diameter in which coarse aggregate having a maximum size of particles of ½ inch is used, concrete should be mixed in the proportion of 1 sack of portland cement to not more than 5 cubic feet of coarse and fine aggregate, measured separately, and in no case should the mixture contain more than 3 cubic feet of fine aggregate to each sack of cement used.

Methods of Manufacture. Strictly speaking, it is not recommended that the intending user manufacture his own drain tile unless the quantity needed is sufficient to warrant purchasing proper equipment, and he has made a thorough study of requirements, knows their importance, and how to apply them. The farmer will find it more to his advantage to purchase tile from some reputable manufacturer who has all the facilities for making and curing, which in an up-to-date plant represent a considerable investment.

Except in sizes 12 inches in diameter and above, it is not practicable to make tile by the hand tamped process, nor is it practicable to make smaller sizes such as are used in greatest quantity for land drainage, by the so-called poured process.

As in all other concrete work, much depends upon using a concrete mixture containing exactly the right amount of water. Mixtures which are too wet do not permit the tile to be removed from the mold immediately after forming, while mixtures which are too dry do not result in dense concrete, hence produce porous tile.

Of course, if a number of farmers in a neighborhood jointly require a large quantity of tile, it might be practicable for them to unite co-operatively in the purchase of one of the modern tile making machines and associated equipment, and after making a study of all requirements, feel reasonable confidence in being able to produce satisfactory concrete tile.

Curing the Product. The most vital factor to success after having observed the requirements of selection, proportioning and mixing materials, is the proper curing of the finished product. In commercial tile making plants the product is steam cured. For such purposes a tight building is necessary and this should be partitioned off into a number of tight chambers, each of which is closed by a tight fitting door. Steam pipe lines are run into the curing chamber, the steam being admitted through a perforated pipe into a trough or similar receptacle, kept filled with water, thus insuring that the curing room will be constantly supplied with moist vapor.

Tile Making Machines. The various tile making machines on the market generally operate by forming the tile with a revolving packer head or with tampers and revolving core to form the shell. In such machines it will be found practicable to use sand having a maximum size of particles of ¼ inch for all sizes of tile up to 12 inches. In sizes larger than 10 inches it will be found practicable to use aggregate having a maximum size of ½ inch. Any deficiency in fine material in the aggre-

gate causes difficulty from the casing, rough surfaces, stone pockets, and pinholes through which water spurts when internal water pressure tests are applied.

Lack of fine material within rather wide limits does not decrease the strength of the finished product. Excess of fine material causes low strength in finished tile which will show seepage under use. The tendency to use an excess of fine material in the aggregate is to be particularly guarded against.

Tests for Quality. To enable the home worker to judge whether the tile he is making or purchasing are of good quality, the following easily made tests may be applied:

a. The surface should be free from cracks and other defects which would tend to diminish the strength.

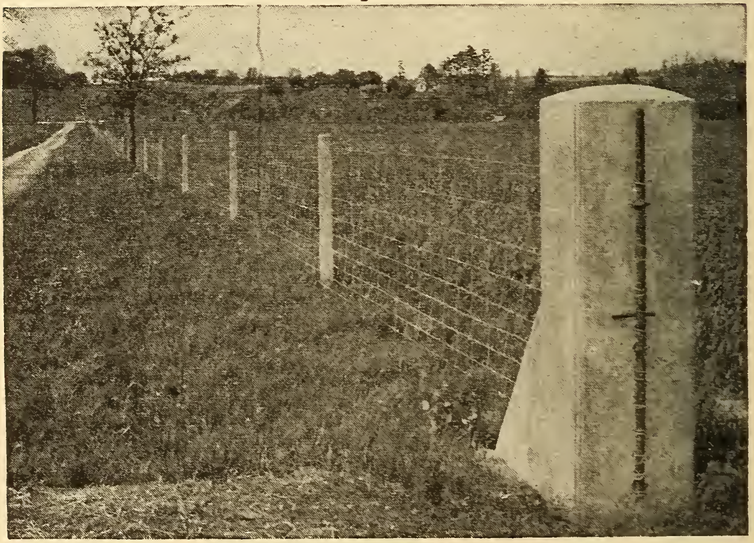
b. A clear, metallic ring should result from striking the tile with a hammer after the concrete is thoronghly hardened.

c. Water marks should show on both the exterior and interior surfaces. Those on the inside are caused by the water being flushed to the surface by the trowelling action of the revolving packer head of the tile making machine. Those on the exterior should show as web-like markings causing minute irregularities of the surface of the tile when jacket is removed.

d. A good tile should not absorb more than 4 per cent of water by weight but in no case should absorption exceed 5 per cent by weight.

CONCRETE FENCE POSTS

Advantages of Concrete Posts. In many localities concrete posts can be made to compete in price with the best wood posts, while the concrete post has one merit that no other type possesses to such a great degree, namely, permanence. A fence made of wood posts is never



Concrete line posts and massive concrete corner posts with monolithic brace cast as part of the post.

paid for. As soon as a farmer thinks he has finished it, repairs begin and increase from year to year. In from eight to ten years these repairs amount to entire replacement.

Like other concrete products, concrete posts, properly made, grow stronger with age. They require neither

Concrete light posts marking entranceway and concrete bubbler drinking fountain.

Concrete hitching post.

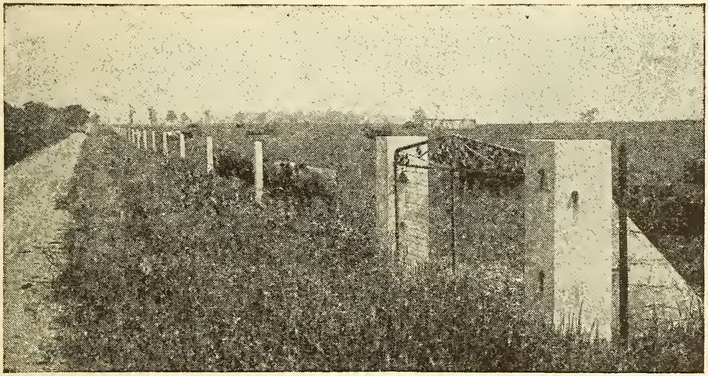
paint nor repairs. They will neither burn up nor rot. They cannot be damaged by insects or worms. One might ask why fireproofness is desirable. Anyone knows there is always a strip of land along the fence line that cannot be cultivated, and one of the most effective ways of killing the insect pests that breed on such strips is to be able to burn it over. Knowing that such a practice will not cause injury to the fence is certainly a source of satisfaction.

Concrete post for the rural route mail box.

One reason why concrete posts should appeal to the farmer is that like concrete block they may be made during the intervals or spare time when work cannot be done in the fields.

Some Essentials of Manufacture. Those fundamentals applying to concrete in general apply also to the concrete fence post. Materials must be clean and properly proportioned. In other respects, however, the con-

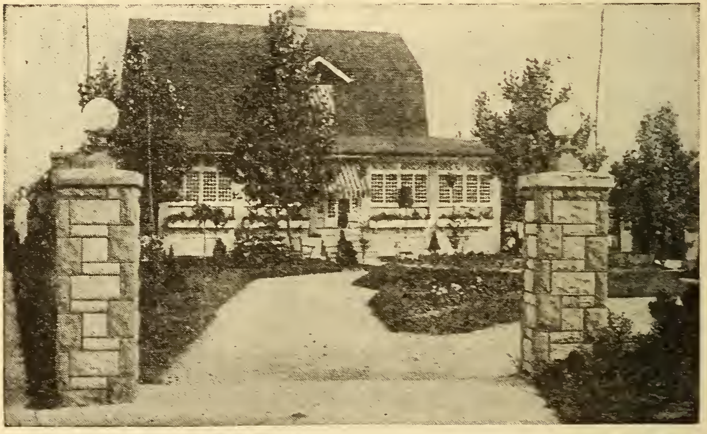
crete fence posts must conform to some requirements that do not apply to concrete work in general. For instance, while concrete block must be made by using a mixture as wet as possible for the type of mold or machine employed, more water may and should be used in the mixture for concrete fence posts. The reason for this is that concrete block are made by tamping or pressing the concrete into the mold. The concrete block contains no reinforcement, that is, it contains no steel rods or wires to increase its strength, while the concrete



A trim line of concrete fence posts with massive concrete gateway.

fence post must be reinforced for reasons which will be given later. This also makes it necessary to use a concrete mixture for fence posts wet enough so that it will be possible to insure that the concrete will settle to all parts of the mold and thus completely surround and everywhere bond with the reinforcing metal. As set in the fence line, the concrete post is subject to certain pulls or strains. The manner in which these forces may act on a concrete fence post can be illustrated by taking a strip of green wood and bending it across the knee until it breaks. When fence wires are attached to posts they

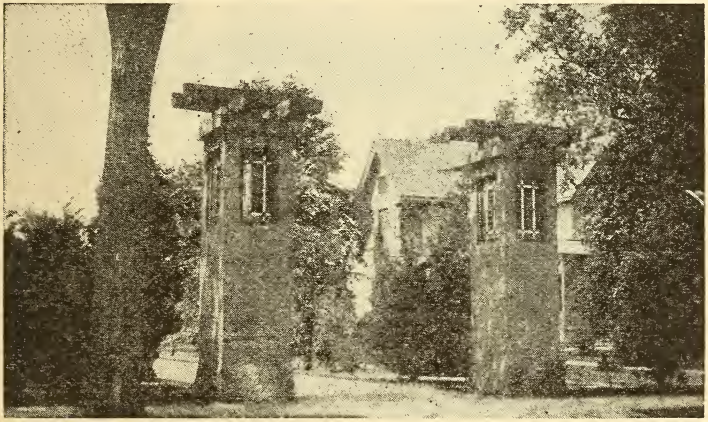
exert a similiar strain, that is, they would bend it and break it if they could. The wood stick bent across the knee until broken will show that the wood fibre on one side stretched until it tore apart, while on the side it was wrinkled by compression. This is the way strains from wires, and from animals attempting to push their way out of the enclosure act on the concrete post. Therefore, metal reinforcement in the shape of rods or twisted wires must be introduced into the concrete to increase



The light posts at this entranceway show a pleasing combination of two faces and colors of concrete block.

strength against strains or pulling. As one can never tell from which direction a force tending to break the post may come, reinforcement must be placed in all four corners of the square post and in similiar relative positions in other shapes of posts. A single rod through the center will not do even though such a rod contains a total amount of metal equal to the several smaller rods. Proper positions for reinforcement in the various common shapes of concrete posts are indicated in an accompanying sketch which shows cross sections of different shapes.

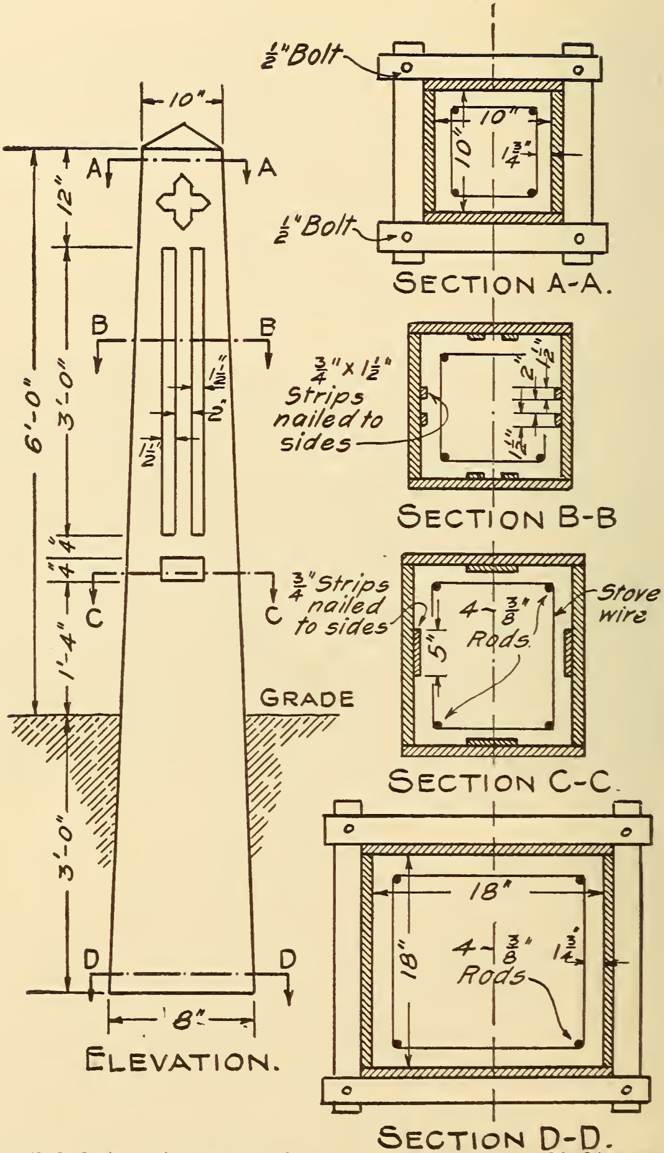
Requirements of Reinforcing. For ordinary line posts reinforcement should consist of ¼ inch round steel rods or twisted square bars or wires having an equal amount of metal in cross section. Trouble always follows an attempt to substitute either plain or barbed wire for the rods or twisted bars because wire usually comes in coils and is difficult to straighten and place in the mold so that it will always lie in the exact position desirable for best results. If twisted wires are used, it should be borne in



Attractive entranceway in which concrete has been used for the posts and columns, which also serve as receptables for lights.

mind that a ¼ inch round rod contains an amount of metal equivalent to a 3-ply twist of No. 9 wire.

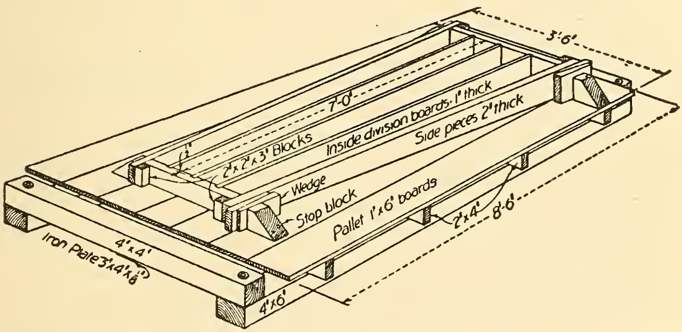
Nearly all failures of concrete posts have disclosed the fact that failure followed because reinforcement had become displaced while placing concrete, that is the rods were either on one side of the post or in the center or somewhere other than in the proper fixed position, as near to the outside surface as possible. In order to make certain that reinforcement is properly placed, several plans have been devised. The most practical one seems to be to use spacers. These consist of pieces of wire



Detailed design of ornamental concrete fence, gate or hitching post showing sections of the form at various heights and in that way suggesting the form of construction.

twisted around the reinforcing rods to hold them in proper relative position. An accompanying sketch offers suggestions. By the use of any such simple device reinforcement may be held in proper position while the mold is being filled with concrete.

Fence Post Concrete Mixture. The mixture for fence posts should be a 1:2:3 concrete. It is not advisable to use pebbles or broken stone exceeding ¾ inch in greatest dimensions. If properly graded pebbles or broken stone cannot be obtained, posts may be made from concrete mixed from 1 sack of cement to 3 cubic feet of coarse

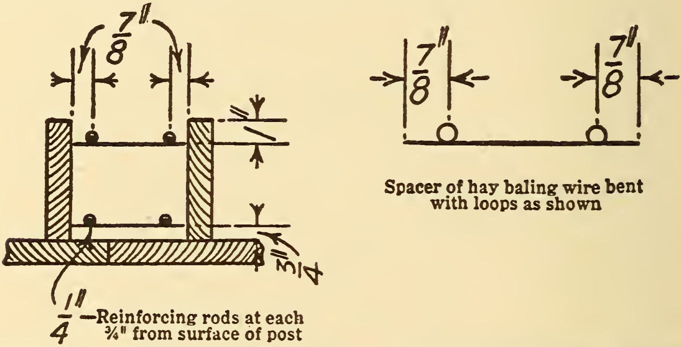


Gang molds for concrete fence posts permitting the molding of four posts at one time.

sand, but such a mixture will require more cement to produce a post of the same strength, hence make the posts unnecessarily expensive. Accompanying tables give examples of mixtures for posts of various lengths and square dimensions.

Filling the Molds. As concrete when placed in the post mold cannot be tamped without dislodging the reinforcement, the mixture must contain enough water so that it can be settled in the mold either by jarring the mold or stirring the concrete with a stick or a rod. Tapping the mold gently with a hammer or otherwise agi-

tating or vibrating the support on which the mold rests insures thorough settlement of the concrete in the mold and a smooth dense surface to the post.



Suggested method of devising spacers to hold reinforcing rods in proper position in a concrete fence post mold while placing concrete.

Commercial and Home Made Molds. One sketch accompanying shows a simple home made mold. This can be expanded so that practically any number of posts can be made at a time, within the limits of time available.

DIMENSIONS			Volume of Post in Cubic Feet	Weight of Post in Pounds	Amount of Reinforcing Metal Required	MATERIALS						
						1-CEMENT 3-SAND			1-Cement 2-Sand 3-Stone or Pebbles			
						No. Posts Per Barrel Cement	FOR 10 POSTS		No. Posts Per Barrel Cement	FOR 10 POSTS		
Length	Top	Bottom					Sacks Cement	Cu. Ft. Sand		Sacks Cement	Cu. Ft. Sand	Cu. Ft. Pebbles or Stone
7' 0"	3"x4"	5"x4"	8	115	Four	14 0	2.8	8.5	19.5	2.1	4.2	6.2
8' 0"	3"x4"	5"x4"	.9	131	¼" R'nd Rods	12.3	3.2	9 7	17.1	2.4	4.7	7.1
7' 0"	4"x4"	5"x5"	1 0	143	Four	11 3	3.5	10.6	15.8	2 6	5.1	7.7
8' 0"	4"x4"	5"x5"	1 1	163	5/16" R'nd Rods	9 9	4 0	12.1	13.8	2.9	5.9	8.8
7' 0"	5"x5"	6"x6"	1 5	213	Four	7 6	5 3	15.8	10.6	3.8	7.7	11.5
8' 0"	5"x5"	6"x6"	1 7	243	⅜" R'nd Rods	6.6	6.0	18.0	9.2	4.4	8.8	13.2

Table giving dimensions of fence posts, volume of concrete per post, with amount of reinforcing material required for the various sizes, and quantity of cement and other materials for ten posts.

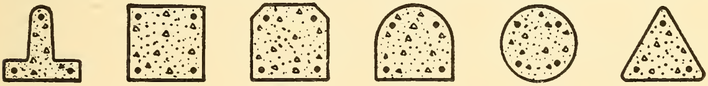
Many different makes of commercial molds are on the market. If any large quantity of posts is to be made forms should be of metal, as they are not subject to warp-

ing and serve almost indefinite use if properly cared for.

The home made mold shown will make posts 7 feet long, 3 by 3 inches at the top and 5 by 5 inches at the bottom, making four posts at one operation.

Removing Post From Mold. After the concrete has been in the mold 12 hours, the wedges in the end are knocked out, releasing the clamps which hold the sides in place so that the sides and partitions may be removed and the posts allowed to remain undisturbed on the pallet until they have become strong enough to handle.

Oiling Forms. The form lumber must be protected from warping by painting with two or three coats of linseed oil and kerosene, which will also prevent concrete from sticking to the mold. The posts should be allowed to remain several days lying flat until they have



Typical sections of concrete fence posts showing proper position of reinforcement in the sections illustrated.

sufficient strength to permit up-ending, but they should not be stacked against each other until they are ten days or two weeks old. Neither should they be allowed to dry out after making but should be protected in the same manner as described for concrete block, by covering with wet burlap or other material or by frequent sprinkling so that they will harden instead of drying out.

Corner Posts and Gate Posts. Corner posts should be larger than line posts and should have additional reinforcement. 8 by 8 inches is a good size for corner posts and they should be reinforced by 4 9/16 inch steel rods or other reinforcement of equal cross section.

Gate posts are generally still more massive and because of that are usually cast in place, forms being made in position where the post is to stand. Reinforcement

required for such posts will depend upon the length of fence line attached to them and the strain or pull exerted by that line, also by the weight of gate that is to be hung to the posts.

In general the principles of fence post manufacture apply to the making of posts intended for lighting standards, for clothes line posts and for hitching posts. For gate posts, corner posts and hitching posts some ornament may be required. This can readily be introduced by so planning the mold that depressed or raised panels or designs as wanted can be provided for before placing the concrete. Also it may be required to give some posts a special surface finish. If so the principles of surface finish as described in another section may be applied.

STUCCO

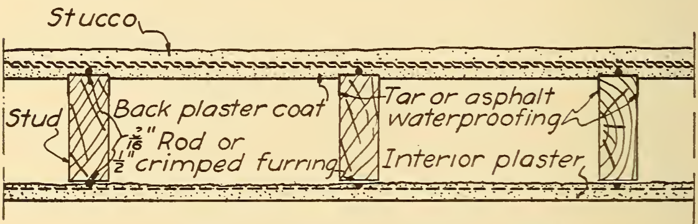
Cement plaster when used to finish the exterior wall of a structure, sometimes when used for interior decoration, is usually referred to as stucco. Stucco work has the advantage of being done without the use of forms and when carefully done gives an attractive appearance to the building so treated. In the case of a frame structure its strength and durability are also increased; likewise there is a measure of fire protection secured.

Stucco has come in for an increasing share of use within recent years, not only for the exterior finish of new buildings but for renovating old frame structures on which the siding or weatherboarding has become so dilapidated as to need replacement. When built new from the ground up, the stucco house consists of a timber frame covered with cement plaster. Stucco work as here referred to should not be confused with the ordinary plastering done with lime-sand mortar. In the modern acceptance of the term, stucco is a cement-sand mortar in which there may be a small quantity of hydrated lime, added to increase plasticity or ease of working the mortar when applying.

Aside from its artistic possibilities, stucco represents real economy. It is practically no more expensive to build a stucco house than one of frame throughout, and if properly built, the stucco-covered frame residence or building will be a money saver because stucco requires no painting and serves to lengthen the life of the underlying frame or timbers in a remarkable degree. The stucco surface is watertight; it affords a great degree of protection against fire from outside sources if the roof

of the structure is also of some fire-resisting material such as cement shingles; and with concrete foundation, stucco will produce a house that is ratproof.

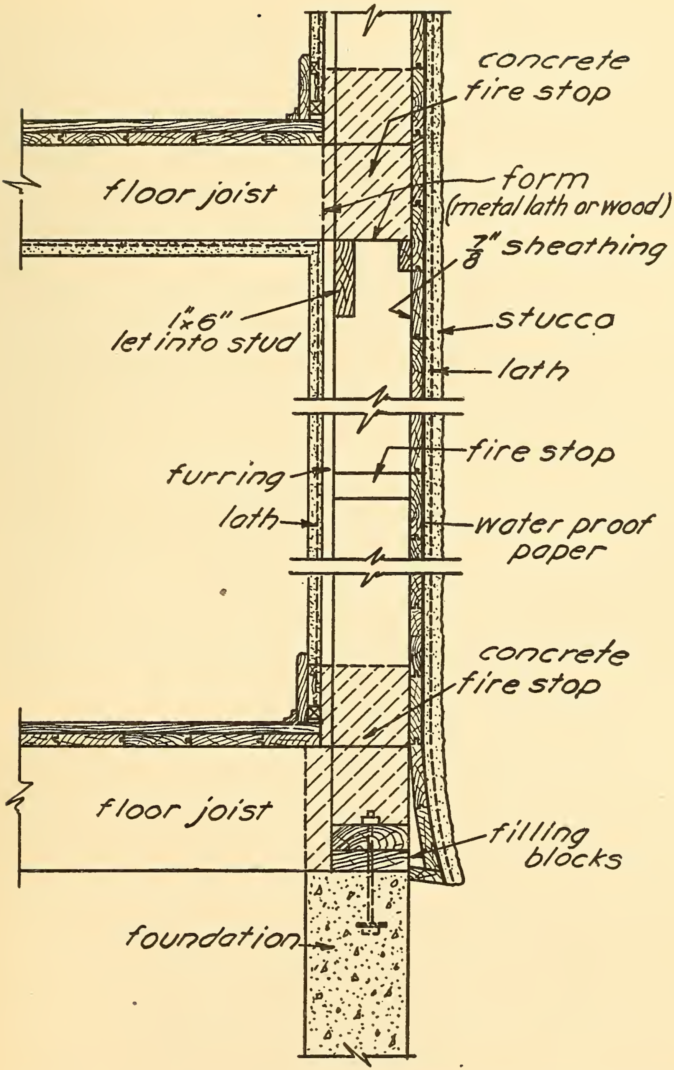
For best results, cement plaster for stucco finish should be applied to metal lath or woven mesh fabric which has previously been fastened to the building studs or sheathing. Another method consists of plastering over wood lath, nailed directly to the wood studs or to furring strips nailed over the sheathing or perhaps over



STUCCO ON METAL LATH
BACK PLASTERED WALL
(Bracing and insulation not shown)

the siding, although it would in all cases be better to remove the siding before furring and lathing the surface to be stuccoed. Several firms now specialize in manufacturing so-called metal lath and woven wire mesh fabric intended solely for use as a groundwork for stucco.

Framing of studding should be carefully done so that the structure to be stuccoed will be stiff enough to form a rigid support for the lath and plaster; otherwise, if there should be settlement or movement of the structure, cracks will eventually follow in the plaster. Dwellings should be covered with sheathing boards to which some type of waterproof building paper should also be applied, before attaching furring strips. In covering old frame buildings the furring strips may be nailed directly upon the weatherboards when the surface is firm and regular, but removing the weatherboarding first is by



Section through house wall showing principal details of framing and other work preparatory to applying a coat of stucco.

far the better way of preparing the surface for stucco. Wood furring strips may be used, and should not be less than ½ inch thick and about 1 inch wide. Sometimes ¼-inch round rods are used with metal lath as furring strips to hold the lath out from the sheathing boards, thus creating a space back of the lath for the plaster to "key", the lath being wired to the rods, which are in turn stapled to the sheathing.

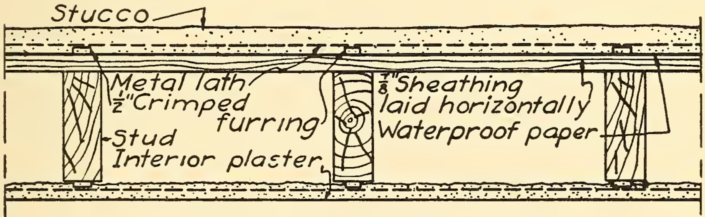
Metal lath is made both with and without stiffeners, these being in the nature of ribs formed in the material at the time it is punched or cut in manufacturing, and with metal lath, metal furring should be used as wood strips are necessarily more bulky, thus interfering with the clinch or bond of the plaster and preventing a thorough coating of the lath at that particular point.

Furring strips and studding should be spaced not more than 16 inches apart in order to give sufficient stiffness to the lath. Each furring strip, whether of wood or metal, should be securely attached to the studding sheathing, or weatherboarding, at distances not greater than 1 foot apart.

One kind of metal lath made from slotted metal is formed into a variety of shapes with different sized openings and can be obtained in various weights; that is, stamped out of steel of varying thickness. The lath is usually coated to temporarily protect the metal from rusting. This type of lath provides a good support for the first plaster coat because of the rough or uneven surfaces, which catch and hold the plaster, but the cut edges of the metal have a tendency to rust where there is any dampness unless the lath is thoroughly covered with plaster on both sides to protect it from atmospheric changes.

Wire lath is made from strong wire of different sizes woven to form a network of fabric having meshes about

one-third of an inch square. Such lath comes both japanned and galvanized. Generally speaking, the galvanized type is preferable, if it has been galvanized after the fabric has been woven, as the coating thus assists to form a tie or bond where the wires of the fabric cross or intersect. Sixteen-inch spacing of furring and studding accommodates 36-inch wire lath, allowing it to lap 2 inches on the side. For straight walls, lath made from No. 18 wire is recommended but for shaping cornices, it is better to use a lighter wire (such as No. 21), as this can more easily be bent to the desired form. Care should be taken to stretch wire lath well over the framework, otherwise when applying the first coat of plaster, the



STUCCO ON METAL LATH.
WITH WOOD SHEATHING

lath will bend back in places under the pressure of the trowel, thus interfering with the clinches of the plaster upon the mesh and giving the wall an uneven surface.

Metal lath should be lapped at least 1 inch wherever joined and fastened to the furring strips or studding in such a manner as to avoid sagging or bulging. When fastening metal lath to metal furring or to overlapping sections of lath, it should be wired to them; for this purpose No. 18 soft iron galvanized wire is recommended.

Wood lath is often used for exterior stucco work as well as for interior plastering but considerable care must be taken to select good lath and to see that they are well wet down before applying the plaster. If the lath are

not wet enough, they will absorb moisture from the plaster, while if too wet they will shrink later and separate from the plaster in places, thus weakening the key. In either case, cracking is likely to follow and the plaster may finally fall off. With metal lath, danger of shrinkage is avoided and the additional cost is not sufficient to warrant one in using wood lath. When wood lath are used, they should be placed so that spaces between them are about ½ inch wide and they should be nailed securely at each point of intersection with a stud or furring strip. At corners, wood lath should be covered with a strip of wire netting or fabric to prevent cracks in the wall at these points.

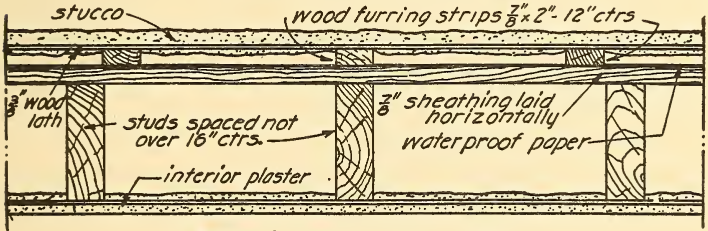
Stucco is used also to renovate old brick structures and to give a desired surface finish to concrete walls, whether the latter are of monolithic or block construction. In applying cement plaster or stucco to walls of concrete or masonry, the surface of the wall must be roughened to provide proper bonds for the plaster and must be thoroughly cleaned by brushing and washing in order to remove all loose particles, dust, etc. These precautions are not necessary in connection with concrete walls from which the forms have just been removed; that is, concrete that has been recently placed, and if in doing such work it is intended to eventually apply stucco, it would be well to not spade the concrete in the forms next to the form faces, thus allowing small gravel pockets to be formed which will assist in providing a good key or bond for the plaster coat.

In masonry walls, such as brick construction, mortar joints should be picked out to a depth of at least ½ inch from the face of the wall, so as to increase the bond between the new plaster and the old wall surface. Where surfaces have been painted, all paint must be removed, otherwise the plaster will not adhere. Chim-

neys should always be furred and lathed before they are stuccoed, otherwise the combination of heat from within and cold from without soon causes the plaster to crack and fall off. All walls must be thoroughly drenched immediately before stucco is applied to prevent the surface from absorbing water from the plaster, which is necessary to proper hardening.

Stucco is usually applied in three coats, designated as the first coat, intermediate coat and the finish coat; but when plastering on masonry the intermediate coat is sometimes omitted and the finish coat applied directly to the first coat. For best results, no plaster coat should be more than ½ inch thick. When the framework of the

STUCCO ON METAL LATH
WITH WOOD SHEATHING



STUCCO ON WOOD LATH
WITH WOOD SHEATHING

wall is composed of wood studding, lath and plaster are usually applied to both sides of the studding, forming a double wall, but for small buildings and sheds, the plaster covering on metal lath applied to the studding outside is often all that is required. This is particularly true of the average farm outbuilding. In such a case the lath should be given a coat of plaster on the inner surface as soon as the first exterior coat has hardened sufficiently. This will thoroughly cover the metal and protect it against dampness which eventually would cause rust; in addition, it will add to the strength.

In order to estimate the amount of cement and sand required to cover walls with stucco, the following table will be of assistance:

NUMBER OF SQUARE FEET OF WALL SURFACE COVERED PER SACK OF CEMENT, FOR DIFFERENT PROPORTIONS AND VARYING THICKNESS OF PLASTERING

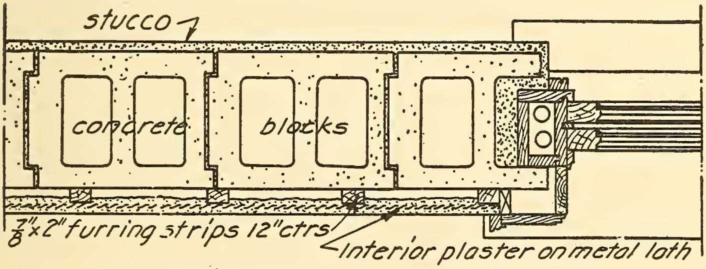
Proportions of Mixture	Materials Sack Cement	Cu. Ft. Sand	Total Thickness of Plaster ½ inch Sq. Ft. Covered	¾ inch Sq. Ft. Covered	1 inch Sq. Ft. Covered
1:1	1	1	33.0	22.0	16.5
1:1½	1	1½	42.0	28.0	21.0
1:2	1	2	50.4	33.6	25.2
1:2½	1	2½	59.4	39.6	29.7
1:3	1	3	67.8	45.2	33.9

This table does not take into consideration waste of mortar. Waste, however, can be lessened by placing a plank on the ground at the base of the wall to catch plaster as it falls; but plaster should never be used after it has once commenced to harden; therefore, only such a quantity as can be used within twenty or thirty minutes should be mixed at one time.

For the first coat, a mixture of 1 part cement to 1½ parts clean, coarse, well graded sand is recommended. Sometimes lime is used in the first coat as well as in subsequent ones but because of the danger of getting unslacked lime into the mixture, only the product known commercially as hydrated lime should be used. If the home worker attempts to slack his own lime and there should happen to be particles in the lime putty which had not been thoroughly slacked, these would slack after they were on the wall surface, due to absorption of moisture, and in expanding would cause a pitting of the surface.

The second and following coats should be applied only after the preceding coats have thoroughly hardened, but preferably before it has time to completely dry out. The first and second coats should be scratched with some

kind of a toothed tool such as shown in an accompanying illustration. This will insure a better bond between successive coats. Immediately before applying a coat, the preceding one should be thoroughly drenched and then painted with a grout of cement mixed with water to the consistency of thick cream. This grout may be applied with a whitewash brush, and the plaster must be put on before the cement paint shows any sign of hardening; therefore, the preparation of surface should not extend very far in advance of applying the plaster.



STUCCO ON CONCRETE BLOCKS
OR OTHER MASONRY

Several surface finishes may be given to stucco—smooth, brushed, roughcast and pebble-dash. The smooth finish is obtained by bringing the final coat to a true and even plane with a wood float or trowel. The brushed surface is secured by the use of a wire brush or broom after the surface has partly hardened. This usually destroys any surface checks and other irregularities and gives a pleasing effect.

To obtain a roughcast or pebble-dash finish, the final coat is dashed against the wall from the hand or from a paddle or swab of tightly-bound pliable twigs. Sometimes a portion of the sand is replaced by an equal amount of small evenly sized pebbles, these being thoroughly wet and mixed in a thin cement-and-water paint,

then thrown against the soft final plaster coat to which they will adhere by being partly embedded. Some practice is required to produce a uniform surface finish by slap-dash or pebble-dash treatment. The texture of this finish will vary in accordance with the size of the pebbles used in the mixture. It is very important that dust and fine particles be screened or washed from the pebbles before they are used.

In doing stucco work it is well to lay out the area to be done in any one day so that one entire wall section can be covered with plaster in one day's operation. This will tend to produce uniformity of texture and color. Great care should be used in measuring materials each time so as not to have variations in color owing to defering proportions of materials used. It is also very essential to protect the plaster from freezing temperatures by covering with some such protective covering as canvas or burlap hung up against the walls and likewise to protect against too rapid drying out from sunlight or wind. In the latter case, the protective covering of canvas or burlap should be kept wet and after the plaster surface has hardened sufficiently to permit spraying with water without injury, the wall should be kept well sprinkled for several days to insure that the plaster will harden under proper conditions, namely, in the presence of moisture.

Sometimes colors are used in the finished coat; only permanent mineral pigments, however, should be used for this purpose and the variety of colors permissible is somewhat limited owing to the fact that many colors fade.

NUMBER OF SQUARE FEET OF WALL SURFACE COVERED PER SACK OF CEMENT, FOR DIFFERENT PROPORTIONS AND VARYING THICKNESS OF PLASTERING

	Materials			Total Thickness of Plaster				
Proportions of Mixt.	Sacks Cement	Cu. Ft. Sand	Bushels Hair*	½ in. Sq. Ft. Covered	¾ in. Sq. Ft. Covered	1 in. Sq. Ft. Covered	1¼ in. Sq. Ft. Covered	1½ in. Sq. Ft. Covered
1:1	1	1	⅛	33.0	22.0	16.5	13.2	11.0
1:1½	1	1½	⅛	42.0	28.0	21.0	16.0	14.0
1:2	1	2	⅛	50.4	33.6	25.2	20.1	16.8
1:2½	1	2½	⅛	59.4	39.6	29.7	23.7	19.8
1:3	1	3	⅛	67.8	45.2	33.9	27.1	21.6

*Used in scratch coat only.

NOTE—These figures are based on average conditions and may vary 10 per cent either way, according to the quality of the sand used. No allowance is made for waste.

MATERIALS REQUIRED FOR 100 SQ. FT. OF SURFACE FOR VARYING THICKNESS OF PLASTER

Proportions	1:1		1:2		1:2½		1:3	
Thickness in.	C. sacks	Sd. cu. yd.	C. sacks	Sd. cu. yd.	C. sacks	Sd. cu. yd.	C. sacks	Sd. cu. yd.
⅜	2.2	0.08	1.5	0.11	1.3	0.12	1.1	0.13
½	3.0	0.11	2.0	0.15	1.7	0.16	1.5	0.17
¾	4.5	0.16	2.9	0.22	2.5	0.23	2.2	0.25
1	6.0	0.22	3.9	0.29	3.3	0.31	3.0	0.33
1¼	7.5	0.27	4.9	0.36	4.2	0.39	3.7	0.41
1½	9.0	0.33	5.9	0.43	5.1	0.47	4.5	0.50
1¾	10.5	0.39	6.9	0.50	6.0	0.56	5.4	0.60
2	12.0	0.45	7.9	0.58	6.9	0.64	6.2	0.69

If hydrated lime is used it should be added in amounts of from 5 to 10 per cent by weight of the cement.

Hair is used in the scratch coat only in amounts of ⅛ bushel to 1 sack of cement.

These figures may vary 10 per cent in either direction due to the character of the sand.

No allowance is made for waste.

ROOFS

Many concrete buildings fall short of what they should be, because finished with some kind of a roof other than concrete. Flat roofs are the simplest type of concrete roofs to build. They are particularly suited to small farm buildings and other small structures.

Concrete roofs must be properly designed. To a certain extent tables can be used for slabs of various thicknesses and span where only small buildings are involved. For larger buildings, involving greater spans, roofs must be designed for the particular structure.

The following table shows thickness of slab required for concrete roofs or roof slabs of various dimensions from four feet square up to sixteen feet square:

TABLE I

THICKNESS OF ROOF SLABS IN INCHES

Width in Ft. Between Center Lines of Walls	Length of Roof in Feet Between Center Lines of Walls						
	4 ft.	6 ft.	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.
4 feet	2 in.	2 in.	2½ in.	2½ in.	2½ in.	2½ in.	2½ in.
6 feet	....	2½ in.	2½ in.	2½ in.	3 in.	3 in.	3 in.
8 feet	....	....	3 in.	3½ in.	3½ in.	3½ in.	4 in.
10 feet	....	....	....	3½ in.	4 in.	4½ in.	4½ in.
12 feet	....	....	....	....	4 in.	4½ in.	5 in.
14 feet	....	....	....	....	....	5 in.	5½ in.
16 feet	....	....	....	....	....	....	6 in.

Load=weight of roof+50 pounds per square foot.

The following table shows the amount of cement, sand and pebbles or broken stone required for roofs of various area and thicknesses:

TABLE

CEMENT, SAND, AND STONE OR PEBBLES

Required for Concrete Slab Roofs. Proportions for concrete 1:2:3. Each cubic yard of 1:2:3 concrete requires about 1.74 barrels of cement, .52 cubic yards of sand, and .77 cubic yards of stone.

WIDTH OF SLAB IN FEET (BETWEEN EAVES)

Sacks of Cement (1 sack = 1 cu. ft.) Length of Roof in feet between eaves	4	6	8	10	12	14	16
4	0.7	2.0	...	...	...	...	...
6	1.0	...	...	...	...	...	...
8	1.7	2.6	4.2	...	...	...	...
10	2.2	3.3	6.1	7.6	...	...	...
12	2.6	4.7	7.3	10.4	12.5	...	...
14	3.0	5.5	8.5	13.7	16.4	21.2	...
16	3.5	6.2	10.1	14.4	20.8	26.7	33.3

Cubic feet of Sand Length of Roof in feet between eaves	4	6	8	10	12	14	16
4	1.4	...	...	...	...	...	...
6	2.1	3.9	...	...	...	...	...
8	3.4	5.2	8.3	...	...	...	...
10	4.3	6.5	12.1	15.2	...	...	...
12	5.2	9.4	14.6	20.8	25.0	...	...
14	6.1	10.9	17.0	27.3	32.8	42.5	...
16	6.9	12.5	20.2	28.8	41.6	53.4	66.6

Cubic Feet of Stone or Pebbles Length of Roof in feet between eaves	4	6	8	10	12	14	16
4	2.1	...	...	...	...	...	...
6	3.1	5.9	...	...	...	...	...
8	5.1	7.8	12.5	...	...	...	...
10	6.5	9.8	18.2	22.7	...	...	...
12	7.8	14.0	21.8	31.2	37.4	...	...
14	9.1	16.4	25.5	41.0	49.1	63.7	...
16	10.4	18.7	30.3	43.2	62.4	90.1	99.8

The following table shows the size and spacing of reinforcing rods for roof slabs of various dimensions:

TABLE

SPACING OF REINFORCING RODS IN INCHES

Width in Feet between Center Lines of Walls	Length of Roof in Feet between Center Lines of Walls: 4 ft.	6 ft.	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.	Size Steel
4 feet..	12 in.	9¼ in.	8 in.	8 in.	8 in.	8 in.	8 in.	¼ in. Rd. Rods
	12 in.	24 in.	36 in.	36 in.	36 in.	36 in.	36 in.	¼ in. Rd. Rods
6 feet..	......	6 in.	4¾ in.	4 in.	4 in.	4 in.	4 in.	¼ in. Rd. Rods
	......	6 in.	12 in.	36 in.	36 in.	36 in.	36 in.	⅜ in. Round Rods
8 feet..	......	......	11 in.	9½ in.	9 in.	7¾ in.	7¼ in.	⅜ in. Round Rods
	......	......	11 in.	22 in.	36 in.	36 in.	36 in.	⅜ in. Round Rods
10 feet..	......	......	......	8¾ in.	7¾ in.	7 in.	6½ in.	⅜ in. Round Rods
	......	......	......	8¾ in.	16 in.	27 in.	36 in.	⅜ in. Round Rods
12 feet..	......	......	......	......	6½ in.	5¾ in.	5¼ in.	⅜ in. Round Rods
	......	......	......	......	6½ in.	12 in.	16 in.	⅜ in. Round Rods
14 feet..						5¼ in.	4½ in.	⅜ in. Round Rods
						5¼ in.	8¾ in.	⅜ in. Round Rods
16 feet..	......	......	......	......	......	......	4 in.	⅜ in. Round Rods
	......	......	......	......	......	......	4 in.	⅜ in. Round Rods

NOTE—Upper figures are for cross reinforcement; lower figures for long reinforcement.

Load=weight of roof + 50 pounds per square foot.

The following example shows method of using the three tables preceding:

Example. Required, the thickness of slab, amount of concreting materials, spacing of lateral and transverse reinforcement, and the amount of reinforcing rods, for the flat slab roof of a building 12 feet by 14 feet in outside dimensions, with 12-inch eaves on all sides. The size of the roof slab between the center lines of walls will be 13 feet 6 inches by 11 feet 6 inches. Referring to Table I, we run down the vertical column at the left to the smaller dimension of the slab, which in this case is 11 feet 6 inches. As this dimension is not given in the table we take the next larger, which is 12 feet. Running across horizontally to the larger dimension of the slab (13 feet 6 inches) we find that this is not given in the

table, but that we must take 14 feet. In the square directly below 14 feet, and horizontally opposite 12 feet, we find the required thickness of the roof to be 4½ inches. By reference to Table II, the quantities of materials required are easily obtained. The size of the roof over the eaves is 14 feet by 16 feet. The table is divided into three parts showing respectively the amounts of cement, sand and pebbles required for roofs of various sizes. The upper portion of the table gives the number of sacks of cement required and those below it give the number of cubic feet of sand and pebbles or stone necessary. By referring to the table we find that the roof will require about 25 sacks of cement, 53 cubic feet of sand, and 79 cubic feet of pebbles or stone.

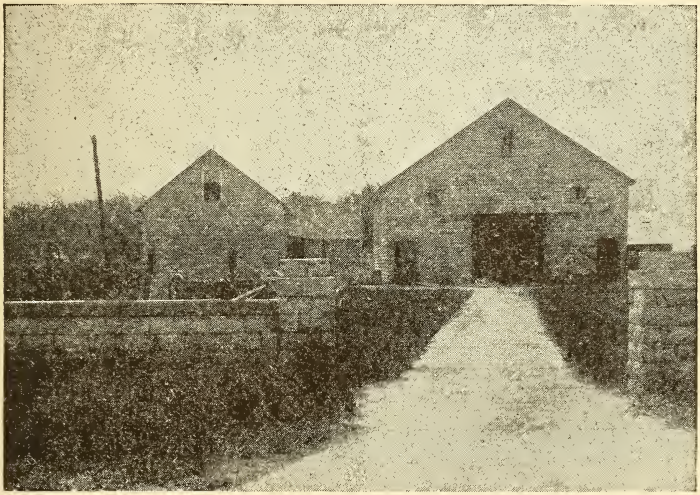
The spacing of the reinforcing rods is shown in Table III. As the roof is 11 feet 6 inches by 13 feet 6 inches between center lines of walls, the next larger dimension shown in the table should be used. These are 12 feet by 14 feet. By running down the left hand vertical column to 12 feet, then running across horizontally to the 14 foot column, we find that cross reinforcement (running parallel to the short sides of the house) should be 5¾ inches apart, and the longitudinal rods (running the long way of the house) 12 inches apart. Round or square ⅜-inch rods should be used, as shown in the column to the right of the table. The roof being 16 feet long and 14 feet wide, over eaves, will require thirty-four ⅜-inch rods 14 feet long, parallel to the short sides, and seventeen ⅜-inch rods 16 feet long, parallel to the long side.

CONCRETE DRIVEWAYS

Construction Requirements. There are probably few who read this book that have not seen concrete streets, roads or alleys—perhaps all of them. Many farms lie along concrete roads that provide easy access to market, and the very utility of the concrete road and the service which it renders should prompt the farmer to connect his farm buildings with the main paved highway by a concrete drive.

The construction of concrete drives of this kind is exactly like that applying to concrete pavement construction in general, the exceptions being that because of the nature of the traffic to which they are exposed, they have to be thicker than would be required for a feeding floor or barnyard pavement for example. The first requirement is that there be a properly prepared foundation or subgrade. Experience has proved that when cracks occur in concrete pavements they are due principally to settlement of the foundation on which the concrete is placed. If a concrete driveway is to be built directly upon an old driveway surface, this should be broken up several inches deep so that it can be leveled and given uniform compactness before any fresh material for filling or grading is placed. If fills have to be laid to establish the desired grade, material for this purpose should be deposited in layers 8 to 12 inches thick and rolled to uniform density with a heavy road roller or tractor or in some way given equally firm consolidation. Concrete should not be laid on fills that have not completed settlement. Regardless of the amount of rolling given fills they will not be compacted as solidly as will result from allowing them to stand the proper length of time. Material for fills should be placed in layers of uniform thickness and dampened or sprinkled preparatory to rolling.

Drainage Important. Proper drainage of the subgrade where a driveway pavement is to be laid is equally as important as proper drainage for concrete highway pavement. Faulty drainage is responsible for cracked slabs due either to settlement or to the heaving from freezing and expansion of water retained beneath the concrete. A poorly drained subgrade is more likely to heave under frost action than one well drained. This heaving may cause



Concrete driveway from the main road leading directly to the attractive concrete block farm buildings. Note also that the entranceway and the enclosure walls have been built of concrete block.

cracking of the slabs and frequently they will fail to return to proper levels, thus causing unequal levels at joints of abutting slabs and in consequence unpleasant jolts to traffic when it passes from one slab to the other.

Drainage of the surface of concrete driveways is provided for in either of two ways. By crowning the surface of the concrete with a strikeboard cut to the required contour, making the pavement higher at the center than at the

edges, or by laying the pavement in the form of an inverted crown so that the surface is dished and the pavement serves also as a drainage gutter. Anyone who has observed the average alley pavement has noticed that drainage is secured by making the pavement lower at the center than at the sides.

Good Hard Aggregate Important. The selection of aggregates is important in concrete driveway construction; more important in some respects than other classes of concrete work because pavements used as driveways are subjected to the impact and abrasion of vehicle traffic. Sand should be clean and hard and the coarse aggregate should be tough. Cleanliness of materials is very important because of the constant abrasion of traffic which will disclose spots where foreign matter like loam or clay is in the concrete.

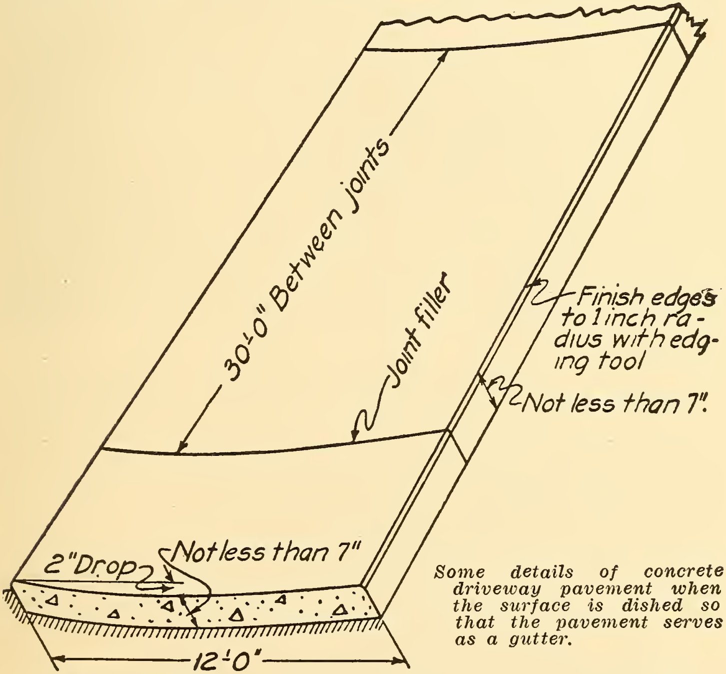
One Course Construction Preferred. Although concrete driveways are sometimes made of two course construction, one course is recommended for the same reason as given when singling this type of construction out for preference in building concrete walks.

The quantity of materials required for a linear foot of concrete driveway of various widths and thicknesses is shown in accompanying table.

It is important that concrete mixtures be rather stiff for this work so that considerable effort will have to be expended to float the concrete to required surface.

Expansion Joints. Joints are usually placed in driveway pavements to provide for volume changes in the concrete due to variations in moisture content and in temperature. Usually these joints are placed from 35 to 50 feet apart straight across the pavement. In general joints should not be more than ¼ inch wide and a prepared filler felt is used between slabs. It is very necessary that these joints be made truly vertical so that the edges of

abutting slabs if they tend to rise due to expansion or heaving will not slide over each other. The surface driveway pavements at joints should be exactly the same level at both sides of joints, otherwise there will be impact caused by traffic when crossing the joint.



Some details of concrete driveway pavement when the surface is dished so that the pavement serves as a gutter.

Reinforcement. Common practice is to omit reinforcement in concrete pavements under 20 feet wide. Over that width, however, reinforcement should be specified. Mesh reinforcement is the material commonly used. The heavy wires should run perpendicular to the center line of the pavement. Each strip should be carefully lapped so as to develop the full strength of the metal.

Forms and Other Details. Forms for driveway pavements may be 2 by 6's staked to proper line and grade. The subgrade or subbase should be sprinkled before con-

crete is placed to prevent it from absorbing from the concrete water necessary to its proper hardening. A templet or strikeboard cut to the desired crown of the finished pavement is the most satisfactory device for obtaining the required pavement contour. A strikeboard consists simply of a plain plank 2 to 3 inches thick cut on the bottom edge to the proper crown of the pavement. Usually a strip of iron is fastened to the lower edge to prevent rapid wear. After the pavement has been struck off as required, it is finished with a wood hand float. In concrete road construction the common practice, however, is to use a piece of belting seesawed and advanced across the concrete to finish the surface to desired regularity. When the hand float is used it is necessary to improvise a plank bridge across the concrete so that the workmen can do the floating from this bridge.

Proper curing of concrete pavements has much to do with their success. As mentioned in discussing construction requirements for floors and other types of pavement, the concrete should be covered immediately after it has hardened sufficiently to permit applying a layer of earth and should be kept wet for a week or ten days by frequent sprinkling. Traffic of teams, loaded wagons and other vehicles should be kept off the surface until the concrete is at least three weeks old.

QUANTITIES OF MATERIALS REQUIRED FOR LINEAR FOOT OF CONCRETE PAVING FOR THE WIDTHS AND THICKNESSES AT SIDES AND CENTER AS SHOWN

Width (feet)	Thickness Side and Center (inches)	Cement (bbl.)		Sand (cu. yd.)		Rock or Pebbles (cu. yd.)	
		1:2:3	1:1½:3	1:2:3	1:1½:3	1:2:3	1:1½:3
9	6-7	0.32	0.35	0.10	0.08	0.14	0.16
16	6-8	0.63	0.68	0.19	0.15	0.28	0.30
18	6-8	0.71	0.77	0.21	0.17	0.32	0.34
20	6-8½	0.82	0.90	0.24	0.20	0.36	0.40
24	6-9	1.01	1.10	0.30	0.24	0.45	0.49

NOTE—Quantities based on the assumption of 45% voids in the coarse aggregate.